METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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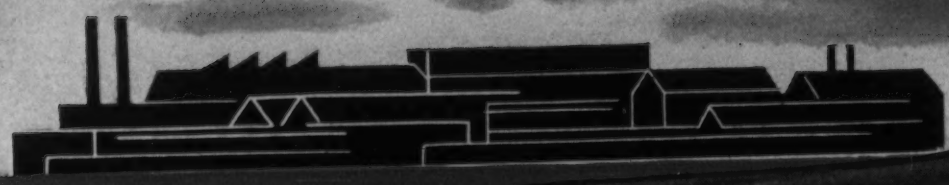
Will you build for tomorrow's

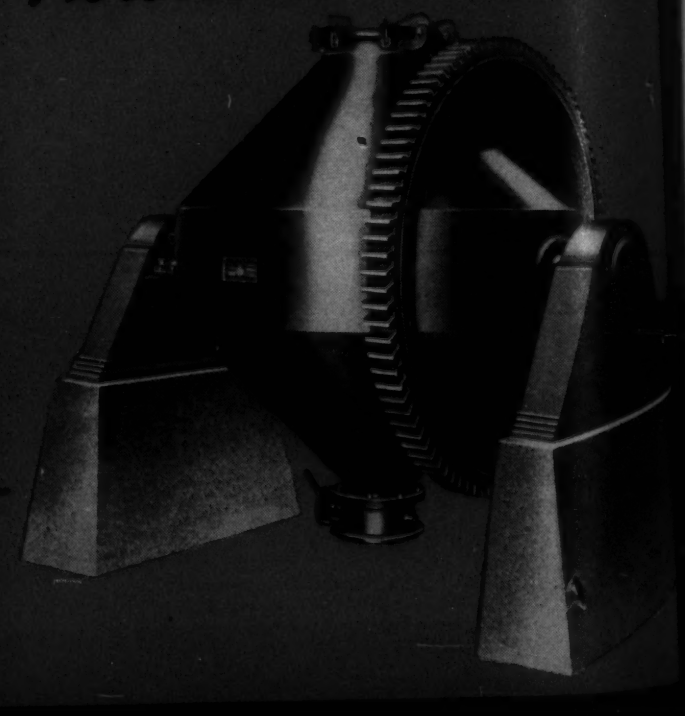
POWDER METALLURGY?



let **PATTERSON**

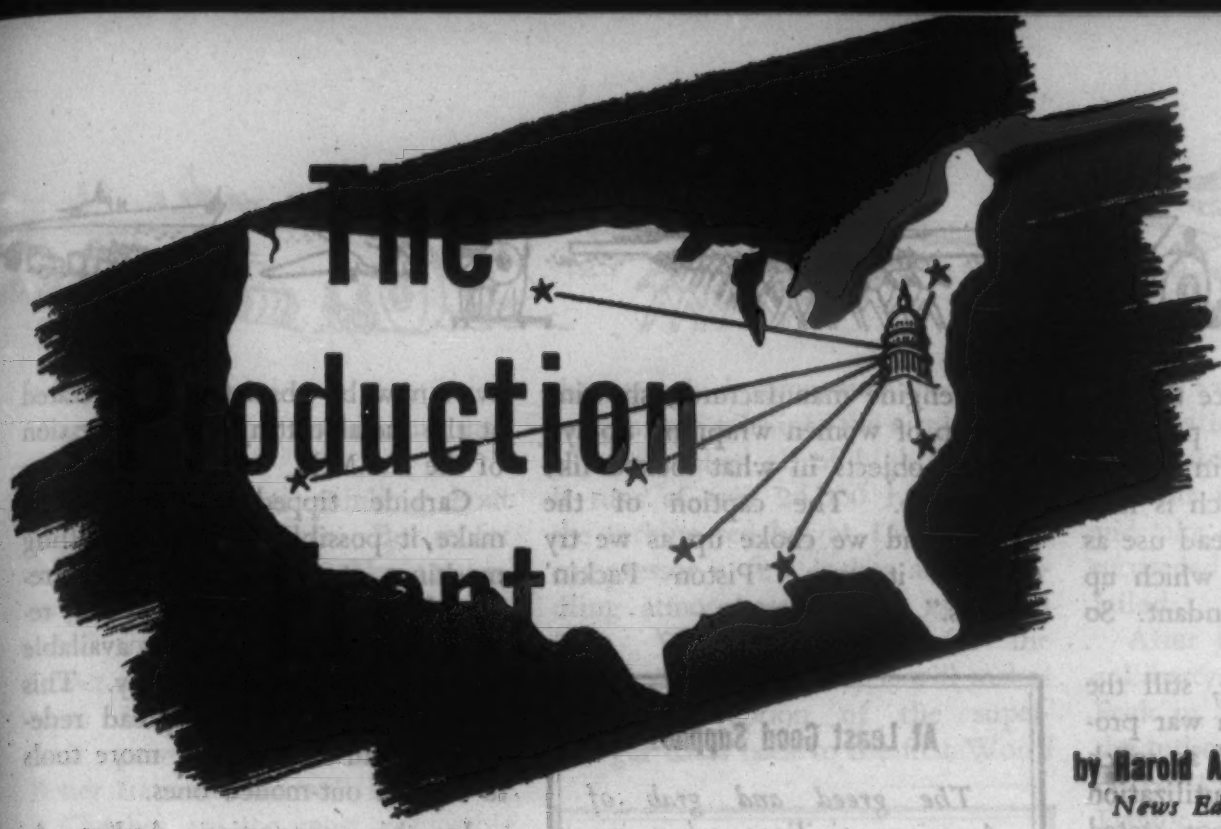
PLAN YOUR PROJECT NOW... AND CARRY IT THROUGH WHEN THE GATES SWING WIDE

Grinding and Blending Equipment for Metal Powders



The Patterson Foundry & Machine C

EAST LIVERPOOL, OHIO, U. S. A.



The layman doesn't realize that steel is tailor-made. . . . Conversion to peace means complicated appraisals, moving out materials, changing pipes, partitions, etc. . . . Make washing machines? But they take labor. . . . Wear and tear on munitions has just fairly begun.

Among topsy-turvy metal supplies pig lead becomes "topsy." . . . Our civilian working force is 51,500,000—to be 66,300,000 in July. . . . Lay that whole d—— song down, Babe. . . . Let's redesign our milling cutters. . . . Unlike you and I, they have too many teeth.

The automobile after the post-war auto. . . . Secret of the secret weapon is out. . . . Background of the turbosupercharger. . . . We still learn from captured enemy equipment. . . . Is there a welding doctor in the house? . . . Several interesting ideas in brief.

In Time of War Prepare for Peace

by Harold A. Knight
News Editor

Those who recall the confusion after the first World War will agree that it is wise to start industrial planning now for the peace.

"Let's Start Making Washing Machines"

A question asked frequently these days is: "Why, in view of our surplus of raw materials and built-up condition of munitions supply, can't we resume manufacture of civilian goods, at least those that do not need rubber?"

Donald M. Nelson answered this question before a group of us recently. "Take washing machines", he said. "These contain both steel and copper. Though these materials are more plentiful and though we have a good supply of munitions, some big change in the war's development might bring about an even greater need for steel and copper than in the past. Moreover, right now we cannot spare the labor to make washing machines."

In this connection the War Department tells us that six of every ten rifles and eight of every ten machine guns must be replaced every year. The wear and tear on equipment in Sicily and Italy has been terrific.

On the other hand, we do not keep as much war equipment stored in strategic points as first regarded as necessary, largely because of our tremendous fleets of transports and freedom from submarine menace. Hence, we keep our reserve ammunition more fluid.

Pig Lead Runs the Gamut

Probably our relative supply of

A well known Washington radio commentator, who specializes on affairs of war and Government, commented at mid-December about a blast furnace that had closed down, releasing many men from jobs. "Yet the railroads are crying for steel. I have asked several prominent men the reasons and none could tell me," the speaker concluded.

Apparently the commentator did not ask the right people, for, in the first place, this company does not make any form of railroad steel—neither rails, axles, wheels nor structurals. In the second place, it is a marginal steel producer, classified as obsolete during normal times.

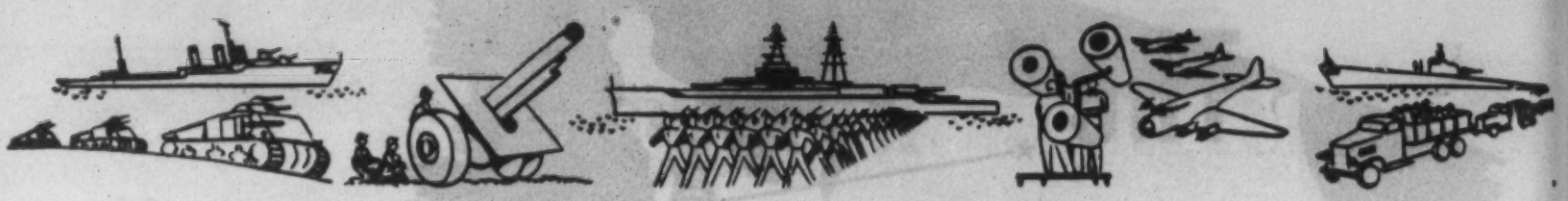
Yet it illustrates the loose thought of the times, the idea of sponge iron from brick kilns, the proposal to build steel plants in every state.

"Anyone Can Convert to Peace"

There are many, too, who decry all this planning for reconversion back to peace. It will be easy, they say, to go back to production of peace goods, the familiar items in which the industrialists have specialized all these years. The real problem, they say, had been the first conversion to munitions with which they were unfamiliar.

Yet, on second thought, it may be a long process for any one plant to get back to peace. The appraiser from the Government, for instance, must go through the plant with a fine tooth comb to place a value on machinery and materials from raw, semi-fabricated and finished materials. Materials must be graded as to second-hand use or mere scrap value. All machinery and materials must be cleared off the floors.

Then, it is possible that the plant must be somewhat remodeled, partitions moved, pipes, wiring, etc. changed. Then the peace machinery must be moved in, as well as a new set of raw materials.



metals is now the best since the war started, with no metal painfully scarce. The chief change in relative supply has been lead, which is now scarcer because of widespread use as a substitute—this a metal which up to now has been most abundant. So go the fortunes of war!

Manpower is, of course, still the No. 1 problem. American war production could be increased as much as 35% through the best utilization of existing facilities and labor, stated John W. Nickerson, director of WPB Management Consultant Div. His remedy is wage incentive plans, and he gave illustrations to bear it out.

OWI finds that it is necessary to hire 17 workers monthly to get a net increase of 3 for every 100 employed. Workers are quitting for better and more essential jobs, because of unsuitability for their work, general restlessness and home duties.

The civilian working force of the nation totaled 51,500,000 on December 1, stated Paul V. McNutt, with a force of 66,300,000 envisaged for July, 1944. As workers are let out from some plants by cutbacks of war orders they are transferred promptly to active plants.

The current decline in construction will have released about 500,000 men for other employment, as of December 31, 1943. Recent occupational studies show that 40 of the 90 construction occupations are to be found in shipbuilding.

Lay That Piston Down, Babe

And now as we shift over from describing "the situation" to the more topical features of this department, it is our custom to leave the more serious side of things for a moment.

We had decided to have no truck with "Pistol Packin' Mama"—call us a mossback conservative, if you will. We merely curled our lip in a sneer when we read an ad in behalf of the glassware division of a department store, urging all "crystal crackin' mamas" to come there to replenish their goblets.

But finally it struck in our field. We received a photo from an airplane engine manufacturer, showing a group of women wrapping up cylindrical objects in what looked like cellophane. The caption of the photo—and we choke up as we try to tell it—was "Piston Packin' Mamas." Forgive us!

At Least Good Supplies

The greed and grab of American civilians when national survival is at stake make a most depressing picture, which needs some sunlight. It is some consolation to review our production achievements.

There are surpluses of many kinds of steel, our original No. 1 critical material. Marginal mines and steel and metal finishing plants are being shut down. In war production critical materials are replacing their substitutes, such as brass for steel in cartridge and shell cases. Pig iron, one of the most basic commodities, is no longer being allocated, but is allowed unrestrained movement. Nickel, zinc, copper, molybdenum, tungsten, etc. are in bountiful supply.

Even the rarer and heretofore ticklish items cause little worry. Take that "wonder metal," beryllium copper, which has proved such a God-send in precision springs. Because of improved supply WPB has relaxed regulations governing distribution. Not only are supply better and deliveries prompter, but the quality of wire from a new New Jersey plant is consistently better than ASTM standards.

More Work for Machine Tool Builders

Perhaps one of the least optimistic groups concerning post-war prospects are the machine tool builders. Yet here considerable opportunity is shaping up. A major portion of all present day milling equipment may even now be obsolete, it was stated at the metal cutting research session of the A.S.M.E.

Carbide tipped milling cutters make it possible to operate milling machines at speeds and metal removal rates never before attained, requiring more power than is available in most such machines today. This will necessitate a widespread redesigning and building of more tools to replace out-moded ones.

In this connection Arthur A. Schwartz, chief tool research engineer, Bell Aircraft Corp., stated:

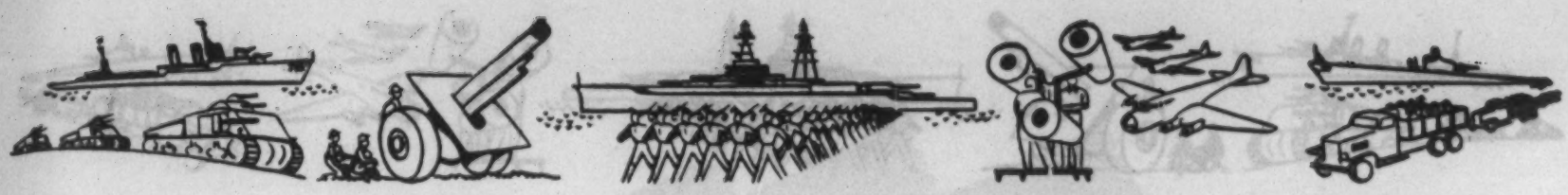
"We believe we have established as a fact that the most of the milling cutters now in use have many times too many teeth, so many, in fact, that if we followed the instructions printed in the catalog by the makers of these cutters or in the various handbooks on the market, about chip load for each blade and if the cut were at all heavy—we would either break the cutter, break the arbor, or stall the motor. That is to say that many if not most of the cutters now commonly used—cannot be used with sufficient feed to operate properly or efficiently.

"We made these statements to high executives of two of the largest cutter makers and their reply was, 'We know that you are right, and what you say is absolutely true, yet we have to make what the public will buy and not what we know is best or right.'

"We claim no patent or no discovery. All this has been done to break what we believe is a pernicious habit of ignoring printed instructions. We hope it will do some good."

Post Post-War Automobiles

There is considerable chitchat among automobile engineers, not to mention the rip snorter type of civilian who likes to sport the sensational, about the post post-war automobile. Now it is recognized that the post-war automobile will be merely a carrying on from where we left off in the urge to satisfy pent-up demand. The post post-war car will come after that, perhaps a year and



a half after cessation of hostilities. Here is where the innovations may step in.

Some engineers are thinking about high-octane gas engines. But so far they are rough riding like an unbroken bronco. They would be decidedly noisy and would unfavorably attract the motor cop. The present types of crankshafts might not stand their powerful unrefined thrusts. Better transmissions will be needed.

Clutches are the most vulnerable parts of our wartime jeeps, peeps, seeps and creeps, breaking down most discouragingly at times. The civilian motorist must have a better clutch for the high octane job.

Anyway, there may not be enough high octane for civilians. Interviews by METALS AND ALLOYS reveal that prospects are slim. The present supply blended for Army and Navy fliers is extremely costly, and is taxing the capacity of refiners to the limit.

Moreover, efficient use of crude stocks of petroleum is being disregarded utterly, and so far its manufacture is a wasteful, non-profitable venture. Nor do any better refining techniques loom on the horizon.

Perhaps we will get to the h.o. civilian engine gradually. Perhaps the first step will be the introduction of superchargers into automobiles.

A more practical line of innovation for the post post-war auto is improvement of heretofore vulnerable parts. Statistics show that mufflers are most often replaced. It is said that just as auto manufacture went out, some much improved types of mufflers with better metals were virtually on the market, such as those made of aluminum-clad steel, copper-bearing steel, etc.

Again, steel channels, which hold up window glass, have been rusting too frequently. Too many bumpers have been corroding.

Turbosupercharger is King

One of the most remarkable and most talked-about (within the realm of military prudence) developments of the war has been the turbosupercharger, which compresses the air and oxygen that goes into the airplane engine in rarified air of high altitudes. It runs at over 24,000 r.p.m., with the turbine red hot at 1500° F., the compressor a few inches away handling atmosphere as low as minus 75°. What punishment for the metals and what a story it will make!

The conception of the supercharger dates back to the first World War, the idea having been suggested in France and brought to the attention of Dr. William F. Durand, chairman of the National Advisory Committee for Aeronautics.

He remembered that years ago a former colleague on the Cornell faculty, Dr. Sanford A. Moss, filled the engineering laboratory with vile smokes and wrote a thesis on the gas turbine. Since then Dr. Moss has developed centrifugal compressors.

The Great Whatisit

by V. M. McConnell

See that metal gleam!
Hear the darn thing hiss.
This is Adolf's dream.
Secret weapon, this.

Full of lies and hate,
Adolf's ammunition.
Plus some extra weight,
His latest intuition.

Cleverly devised,
Goes off with a bang.
Won't they be surprised,
It's a boomerang!

Now a turbosupercharger is a combination of the gas turbine and a compressor. So, it was natural to demand that Dr. Moss come back and take care of his twin babies. He succeeded where the Frenchmen failed.

After ground tests Dr. Moss took a Liberty motor to the top of Pike's Peak in September, 1918. Without the turbo, the engine, which had produced 350 h.p. at ground level in Dayton, Ohio, produced only 230 h.p.—but with the supercharger the engine turned out 356 h.p.

Mechanical advances made successful the gear-driven charger around 1926, where the compressor is driven from the shaft of the combustion engine through a speed increase in gearing, working satisfactorily up to 15,000 ft.

Thereafter substantial progress was made, so that by 1939 the modern turbosupercharger was in small scale production.

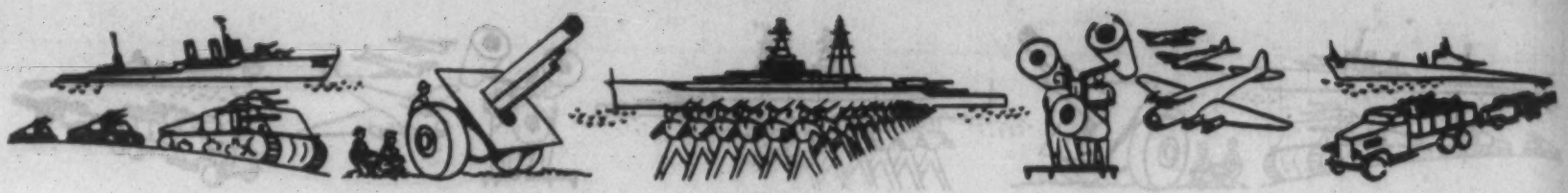
The turbine wheel works on the general principle of the old-fashioned water wheel or windmill, and is driven by exhaust gases from the engine, which are fed to it through a system of piping and nozzles.

Moreover, it operates largely automatically, the more rare the atmosphere, the faster the revolutions. Germany has developed good 2-stage geared superchargers, but probably no turbosupercharger.

Dr. Moss, General Electric engineer, will be tendered the Sylvanus Albert Reed award by the Institute of Aeronautical Sciences in recognition of a "notable contribution to aeronautical engineering" on Jan. 24. But medals and awards are no novelty for Dr. Sanford A. Moss, a bespectacled savant, who camouflages some of his scientific brilliance behind mustache, beard and side whiskers.

Captured Axis Equipment

Approximately 1,100 major types of Axis ordnance equipment, comprising 600,000 items, have been received at the scientific testing laboratories at Aberdeen Proving Ground, Md., and at our six arsenals.



Pressed as Germany must be for vital alloying elements, the core of the projectile for the Gerlich 28/20 anti-tank gun is made of tungsten carbide. This armor-piercing projectile attained muzzle velocities above 4,000 ft. per sec., but was rated as rather ineffective, because the projectile was too small to stop a tank unless it would hit the power plant.

German welding techniques are probably inferior to ours, but captured German tanks showed welded construction for nearly all the armored sections. It contrasted sharply with the cast armor of most American models, where smoothly rounded turrets made the German types look clumsy by comparison.

Italian tanks were probably the most antiquated from the viewpoint of industrial techniques, most of their armor being riveted or bolted in place.

The latest Japanese rifle is a manually-operated, bolt-action weapon, with an increased bore of .303 calibre, but it is inaccurate at a range of more than 350 yards, while our Garand is accurate at greater distances.

The Jap light machine gun fires 30 rounds in 3 sec., with an effective fire rate of 200 to 300 rounds per min. It is accurate at short distances, but at 500 yards it does not compare with the .30 calibre Browning, firing 500 to 600 rounds per min.

"Ice Follies" and Chemical Show

"Is there a doc-tor-r-r in the house?" Do you remember, reader, in the early days of the movies, perhaps, when the theater manager halted the flickers, strode up front and in a stentorian voice propounded this question? There was a rustle and a little baldheaded man with a black case in the third row importantly stumped down the aisle. You pictured, as the sweat came to your forehead and goose pimples stood out on your arms, a bloody accident in the street ouside. You did not learn until later that a pregnant woman had fainted in the lobby and that the "doctor" was actually a veterinarian.

And so, there proved to be a doctor in the house at the 19th annual chemical exposition in Madison Square Garden early in December. One Howard Post is chief engineer at the Garden. Time hanging heavy, he took a stroll to have a look-see at the chemical exhibits in his building. An hour later, before the opening number of the "Ice Follies," one of the intricate parts, made of bronze and copper, of the ice-making machines broke down. A new part would have to come from Syracuse, N. Y., with a delay of at least three weeks.

Engineer Post remembered his leisurely meandering at the chemical show. To make a short story even shorter, inside of 10 mintes Bent Laune of Eutectic Welding Alloys Co., New York, had successfully repaired the ice-making gadget with "Eutectic Alloy No. 1800," a low melting alloy with high tensile strength.

Said Engineer Post, according to the publicity release: "Eutectic is about the only thing I know that could successfully weld a 0.003 in. strip onto a heavy flange."

Note on post-war: Look for a low-temperature welding outfit hanging on the wall beside every fire extinguisher in public places. The printed directions: "In case of damaged parts, break glass and remove welding outfit."

Spot Testing the Situation

Overall war production in 1944 is scheduled for 80% above that for 1942, states Charles E. Wilson, executive vice chairman, WPB.

Gas turbines, which are "just around the corner," will first be used in locomotives where some economy can be sacrificed for convenience, states Westinghouse engineers. They will also be used in power houses and located at war load centers close to the point of utilization of electrical energy. Weight and space reductions may make them attractive for ships.

Here is an item in the category of man-bites dog. Steel Recovery Corp. disbanded December 31, having spent less than 1% of what the Government expected it to spend. Moreover, it went out of business voluntarily because it realized that it had completed its job. All of which reminds us of that well-known series of cartoons, "This Ain't the Army."

In writing about the Steel Corporation, E. M. Voorhees, chairman of its finance committee, said: "By the use of tools a man's work for an hour in 1902 resulted in 29.7 lbs. of steel; by 1942 the hour of work resulted in 60.6 lbs."

The raw materials list of Westinghouse covers 8000 to 10,000 types of materials from all parts of the world. Many sources of supply, such as of tin, mica and shellac, are now in Japanese hands.

Based on its findings that a single 10-ton truck is better than two 5-ton trucks or five 2-ton trucks, the Army will receive approximately twice as many heavy trucks in 1944, as it did in 1943.

One type of Army small arms cartridge, at the instant of firing, develops a pressure of over 50,000 p.s.i., rotating the bullet at over 200,000 r.p.m. and making it travel 2,000 miles per hr.

Employees of Irving Subway Grating Co., Long Island City, are turning in constructive ideas for post-war, such as steel mesh mats for muddy roads, stairways and cellar floors.

A furniture store recently advertised a new kind of mattress containing a small motor, which, by means of special spring arrangements and mountings, transmits 5,000 pulsations a minute, thereby giving gentle muscular massage and nerve relaxation, states the house organ of Wallace Barnes Co., Bristol, Conn., maker of springs.

The jeep does 24 separate tasks in the armed forces, and 36 civilian postwar uses are suggested.

Materials - Specifications for the Designer

It is now being recognized by the various technical societies concerned that our system for specifying materials needs revision. METALS AND ALLOYS has commented editorially several times upon the growing tendency to specify steels by properties or performance rather than by chemical analysis. The American Society of Mechanical Engineers has conducted a questionnaire among its members to find out what subjects were of greatest interest and importance to them, and in their official organ, *Mechanical Engineering,* for November announced that there was "a widespread and deeply rooted interest in metals and in knowledge of their use in design, their properties and applications, and the manner of working them."

The complaint of the mechanical engineers is that, although they are often the ones who must design the parts using the materials, the specifications and properties of the materials are usually written for the trained metallurgist alone. There exists, then, a need for specifications of the standard materials from the standpoint of the needs of the designer rather than of the supplier.

Dr. H. W. Gillett has lucidly presented the need for bringing the metallurgist and the engineer closer together, especially in regard to selecting and devising materials with particular sets of properties rather than with inflexible compositions, in a recent report to the War Metallurgy Committee published in *Steel.*

The same thought so far as plastics are concerned was expressed at the annual meeting of the Society of the Plastics Industry, held in New York City, Nov. 8 and 9. A subcommittee of that organization's technical committee, under the direction of N. J. Rakas, announced that it was preparing material to meet this need.

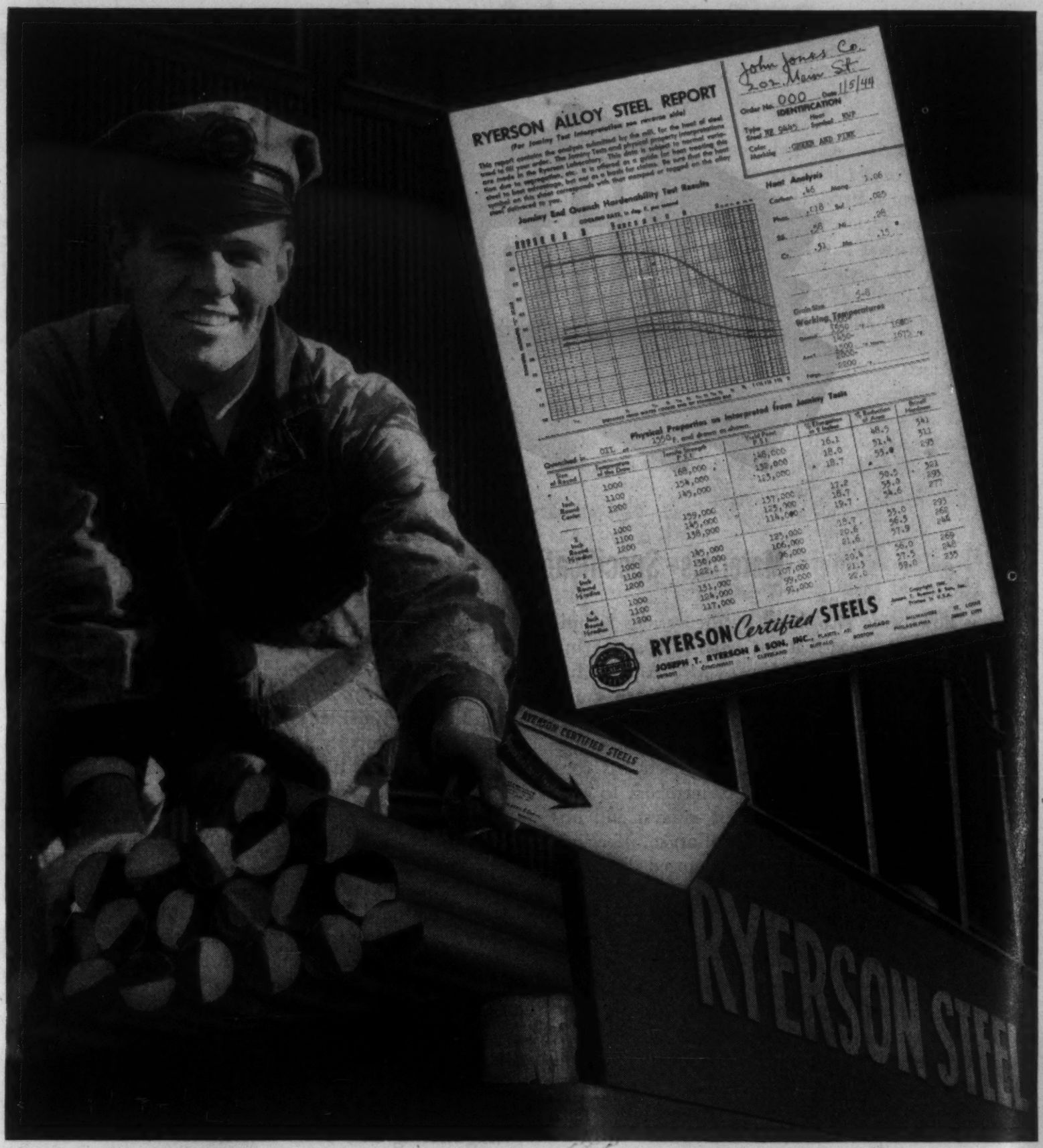
R. G. McElwee, of Detroit, addressing the Junior Metropolitan Group of the A.S.M.E. in New York Nov. 23, stated that specifications for gray cast iron based upon chemical analysis only were practically worthless, and insisted that not only physical properties, but *the* property actually involved in the service considered be the basis for selection.

Mr. McElwee added that in the case of the principal grades of steel the properties and chemical composition were so well standardized that chemical specifications would be of value. It is apparent from the A.S.M.E. questionnaire, however, that the design engineers would like to have this information in a more "readily comprehendible form."

Tables, charts and graphs are of course useful to the designer as *guides* to the selection of materials for specific services, and should not be presented or used as semi-automatic devices for pressing a button and directly extracting exactly the right material. But more of them even as guides are required by engineers, and it was partially to fill that need that the "Engineering File Facts" series was started in this magazine last year. Dr. Hoyt's "Metals and Alloys Data Book" and Nordenholt, Kerr and Sasso's "Handbook of Mechanical Design" are compilations of data prepared from the design engineer's as much as from the metallurgist's viewpoint and the former seems indeed destined to become the engineer's property-data bible on metallic materials.

In view of the magnitude of this need it is gratifying to see so many technical societies turning their attention to it, for out of all this activity is certain to come some real help to our engineering designers —the creative factors in the metal-working industries.

—K. R.



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Silver Anniversary of the A. S. A.

A noteworthy and prominent organization celebrated its twenty-fifth, or silver, anniversary last month—the American Standards Association.

In 1918 five engineering societies—the Civil Engineers, A.S.C.E.; the Mechanical Engineers, A.S.M.E.; the Mining Engineers, A.I.M.E.; the Electrical Engineers, A.I.E.E.; and the Testing Society, A.S.T.M.—organized the American Engineering Standards Committee. This later became the A.S.A.

This association has enjoyed phenomenal expansion. At the close of 1943, it had 77 members—20 technical societies, 47 trade associations, and 10 Federal organizations. It started in 1918 with 3 standards—today it has promulgated 657 in many branches of industry.

The work which this very important association has done and is doing deserves the highest praise—the coordination and approval of standards for metals, alloys, textiles, safety and many others—for the benefit of industry as a whole and for the consuming public. The standards receiving the approval of the A.S.A. are of the highest quality and reliability. The Society's work has been extremely helpful in the general wartime program of conservation-through-standardization.

May the next quarter century of the American Standards Association be as successful and productive as the last twenty-five years. Surely in the post-war era there will be even more need by industry and the public for such constructive and helpful work.

—E. F. C.

Metal-Working Expendables

An interesting engineering technique involves the use of a material in metal-working operations that disappears completely when the process has completed itself. Usually the idea involved is very clever yet so simple that a frequent remark is: "It's a wonder somebody had not thought of it before."

We were intrigued when we first ran across an application of this idea. A telephone and telegraph company had to lay complicated cables and conduits in trenches. The assemblies were so delicately adjusted that the wear and tear, stretch and strain of placing them in a trench wrought havoc with their mechanisms.

So some ingenious engineer evolved a plan. After the trench was built and immediately prior to laying in the trench, blocks of ice were placed therein with the cable or conduit on top. The melting of the ice allowed for gentle placing and settling of the materials and with much greater delicacy than if done by hand or machine. One might say that nature put on the finishing touches — the rule of nature which declares that ice become liquid above 32 deg. F.

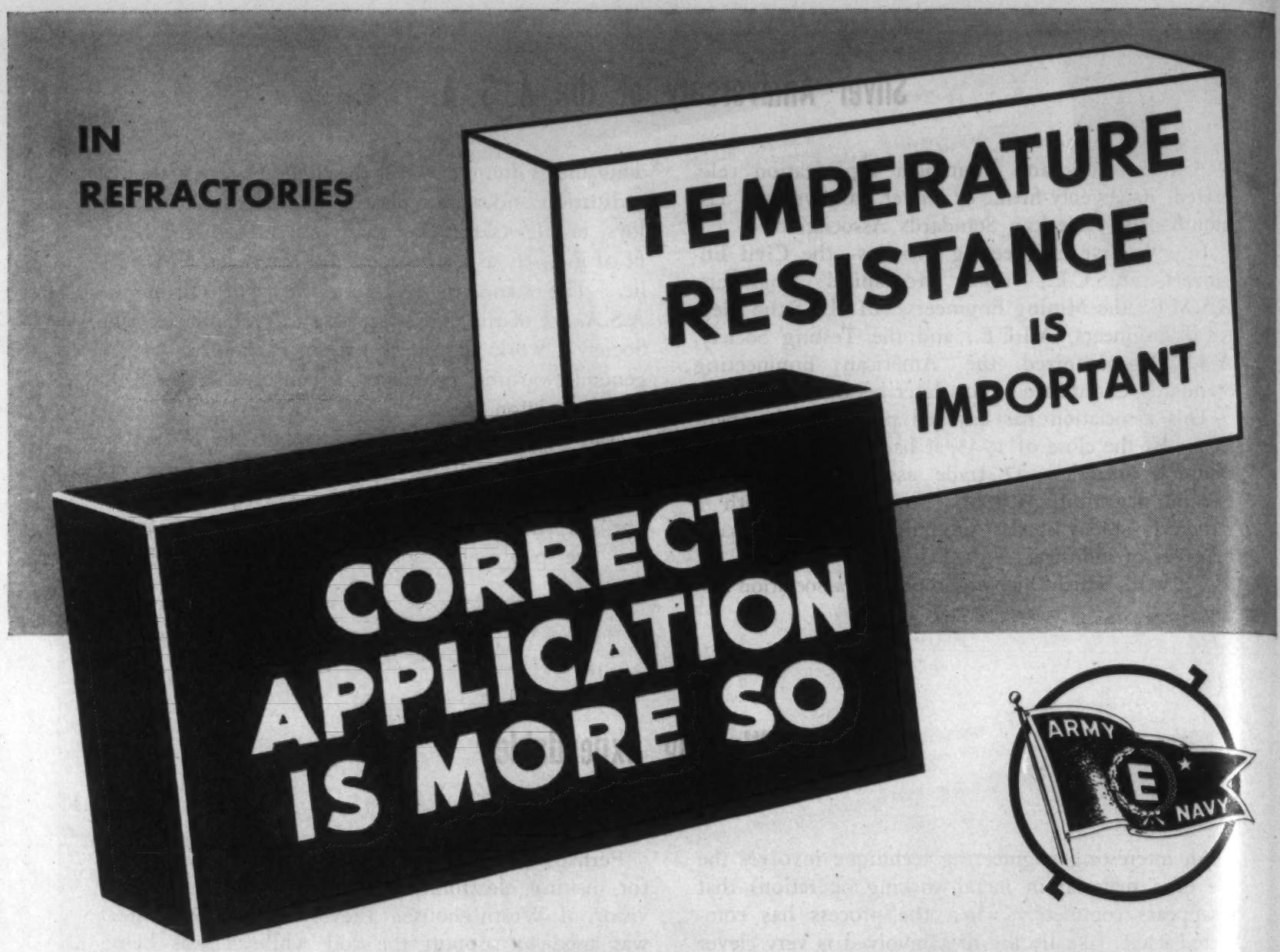
Another instance of the material which "wasn't there" at the end of the operation is the lost wax process developed in the jewelers' craft and elsewhere for the manufacture of small precision castings. Here the wax forms the replica of the part around which the mold is formed, the wax accommodatingly disappearing on heating the mold.

Perhaps even more spectacular is a new process for making electronic tubes used at the Lamp Division of Westinghouse. Previously a piece of steel was used to support the coil while it was being welded inside the tube. But the steel support was always difficult to remove when the job was done. Moreover the steel had to be split with a saw for it became difficult to remove as the coil tightened around it. Finally a so-called successful removal of the support actually often put the coil out of alinement.

So, some simple-minded soul with genius somewhere in his make-up devised a support of spaghetti instead of steel. The same electric current which is passed through the coil to burn out impurities in the metal burns away the spaghetti. It is so successful that one spaghetti manufacturer makes his product in a special die to produce the correct diameter for Westinghouse.

All these and many others — the use of paper on the inner walls of some ingot molds to cushion the first impact of falling metal on the mold bottom, the incorporation of volatile waxes in metal powder mixes to produce a controlled porosity on subsequent heating, etc. — are instances of expendable materials. However, the American genius for thinking up simple and clever things must never be allowed to become expendable. It is such genius that carries us on to victory.

—H. A. K.



ARMY E NAVY

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Foreword . . .

As the Tide Turns

Engineers in America's metal-producing and metal-working industries can look with satisfaction on the record of their 1943 performance as reflected in war's dark mirror. Through their efforts as much as for any other reason, the new year finds the axis everywhere in retreat with the initiative transferred permanently to the United Nations. The shifting currents of many battles have finally merged into the turn of an enormous tide.

Men of industry see the turn of that tide as the summation of countless engineering problems that had to be solved before it could happen. They see a year of shortages met and overcome in turn, a year of unbelievable production records. They see program cutbacks and changeovers to new products requiring different materials, methods or equipment. And they see, sadly, strikes, sabotage and selfishness in some high places.

This was the year in which the stream that had been a trickle in 1941 became an overwhelming torrent. At its close, we have virtually enough steel, more than enough aluminum and even sufficient material to resume the manufacture of a few selected household products. Although some shortages still exist, although many problems remain and although the war is far from over, engineers may now peer into the future with assurance and hope.

This much they know: 1944 will be a year of Victory. In Europe the pace of conquest will be swift and the end may be sudden. Against Japan the fight must go on for many months, and to speed its close engineers will be expected in 1944 to provide even higher production levels than in 1943.

Nineteen hundred and forty-four will mark, too, the beginning of the "post-war" era. There will be considerable controlled reconversion to civilian products as materials and manpower become increasingly available some months hence. Engineering-wise, this operation will be as painful and as great a challenge to technical ingenuity, to the enlightened use of the best materials and methods, as was the war-conversion era of 1941-1942.

So as the tide turns, the editors of M&A present in this issue's engineering review of 1943 in the war-vital metal-producing and metal-working industries a record of the basic reasons for its turning and a suggestion of the still unsolved problems that may yet delay our progress. An innovation this year is the detailed index (on the next page) of the contents of the review section. The articles are more concise than those of a year ago, and the review as a whole is somewhat shorter than last year's, as part of a program *to increase the editorial content of the remaining 1944 issues of M&A by several pages per month* and still stay within the 75 per cent paper quota under which publishers must now operate.

Within these limitations, your editors have sought not only to report the year's technical developments briefly and accurately, but to provide a useful base for projecting the engineering trends and production problems that 1944 may bring to the metal industries. And throughout the year we will take more space than ever before to discuss those trends and to aid in the solution of those problems, with continuing emphasis on the presentation of *engineering* data about materials and methods for all our readers. —*The Editors*

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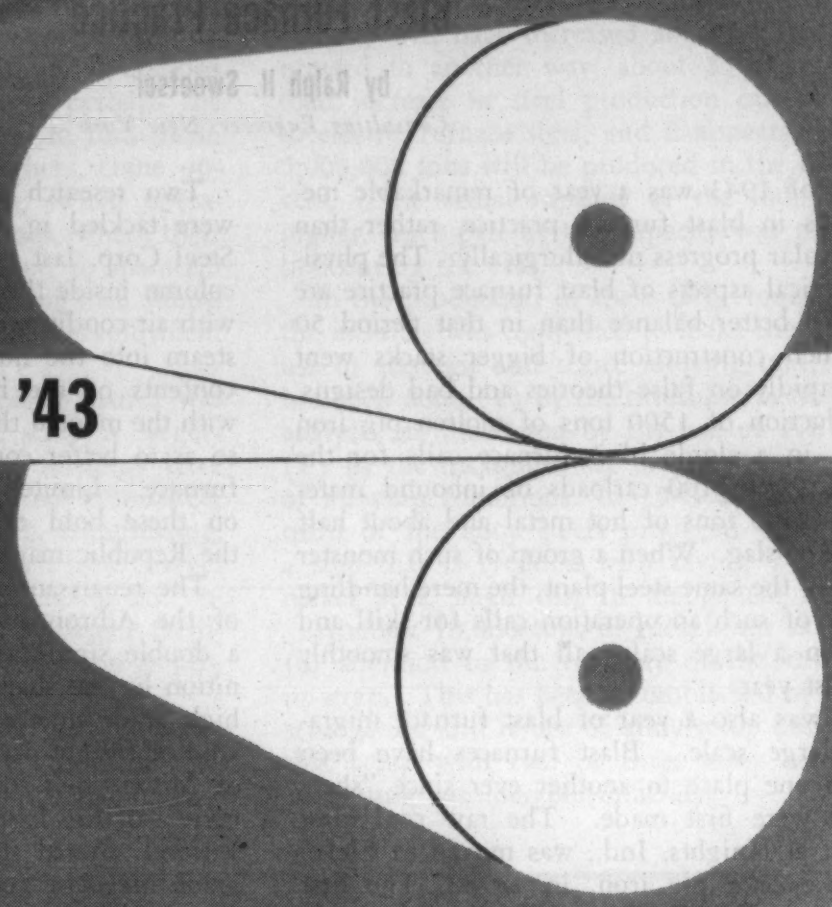

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Blast Furnace Practice

by Ralph H. Sweetser

Consulting Engineer, New York

The year of 1943 was a year of remarkable mechanical feats in blast furnace practice, rather than of any particular progress metallurgically. The physical and chemical aspects of blast furnace practice are now in much better balance than in that period 50 yrs. ago when construction of bigger stacks went ahead too rapidly on false theories and bad designs.

The production of 1500 tons of molten pig iron per 24 hrs. in a single blast furnace calls for the handling of 90 to 100 carloads of inbound materials and of 1500 tons of hot metal and about half that tonnage of slag. When a group of such monster furnaces are in the same steel plant, the mere handling of the traffic of such an operation calls for skill and equipment on a large scale—all that was smoothly done this past year.

Last year was also a year of blast furnace migration on a large scale. Blast furnaces have been moved from one place to another ever since "sheet iron" stacks were first made. The raw coal blast furnace built at Knights, Ind., was moved to Cleveland to make coke pig iron, in 1878. The first Carrie furnace at Rankin, Pa., an 80 by 18 ft. stack, was moved from Ohio in 1883. In World War I one furnace was moved from Alabama to India.

All these were light weight movements compared with what was completed last year, when the two 800-ton Joliet blast furnaces were moved to Utah and Minnesota, a total movement of 725 carloads, according to *Engineering News Record*. The 1943 records show one blast furnace shipped out of the country—an idle stack from near St. Louis, Mo., to Monclova, Mexico.

Two research problems in blast furnace practice were tackled in a large-scale way by the Republic Steel Corp. last year, one at each end of the stock-column inside the blast furnace. The first had to do with air-conditioning in the very wet way of injecting steam into the hot blast to help control the silicon contents of the hot metal; the second had to do with the mooted theory of very high top-gas pressures so as to better control chemical reactions inside the furnace. Limited space prevents further comments on these bold experiments, except to congratulate the Republic management on its progressive attitude.

The renaissance of the magnetic iron ore industry of the Adirondack region of New York State has a double significance at this time: First, the recognition by the steel industry of the intrinsic value of high grade sintered magnetic concentrates almost devoid of freight-paying moisture—the November issue of *Mining and Metallurgy* discusses this remarkable revival of the Eastern magnetites Secondly, there is a trend toward the direct reduction of these high grade magnetic concentrates, especially in the finest sizes which are sometimes almost pure iron oxide, using hydrogen at low temperatures.

Sponge iron is still a very live subject, though shorn of some of its fantastic and irritating claims. The attitude of the sponsors of the more likely processes has changed from that eagerness "to produce scrap that is so much needed in the war effort" to the real facts in the case, namely, that of producing a superior metal product, perhaps at a little higher price (and perhaps not) but worth more than scrap.

Steelmaking

by Harold K. Work

Manager of Research and Development
Jones & Laughlin Steel Corp., Pittsburgh

The outstanding developments in steelmaking during 1943 were the measures which enabled the industry to maintain production over the year at levels approaching and at times even exceeding 100 per cent of theoretical capacity. It appears at the date of writing that 1943 production will be about 90,000,000 net tons, and this in the face of manpower, equipment and raw material restrictions never before faced.

Production has been maintained partly by increasing the amount of steelmaking equipment and partly by increasing the "availability" of furnaces. The "availability" of a furnace may be expressed as a percentage obtained by dividing the number of hours in a year a furnace is on fuel by the total number of hours in the year; in times past a figure of 90 to 92 per cent was considered satisfactory but today figures of 95 per cent or more are not infrequently obtained.

The principal factor in attaining such figures has been the careful scheduling of repairs and rebuilds well in advance of the actual shut-down, so that minimum time is lost. This practice has resulted in a shattering of rebuilding and relining records.

Selective Service has, of course, continued to drain the plants of their younger men. Their loss has been made up to a considerable degree by women, not only in clerical positions and light finishing operations but also in the open-hearth shops — perhaps the last place where it would be expected to find them. Women are being employed as weighers, crane operators, bricklayer's helpers, welders, switch operators, laborers, and in various other jobs, where their performance has been sufficiently good to maintain production. It is the opinion of operating men almost without exception, however, that their employment is strictly a war measure.

The scrap situation is somewhat easier than it was a year ago, but the quality of the scrap is largely poor. The difficulties of charging turnings have been reduced in many mills, although not eliminated, by resorting to briquetting, shredding, compressing, and other expedients. The use of high iron charges is common — figures of 80 per cent being not unusual in some shops. Mills having Bessemer facilities are duplexing to get as much production as possible from their open-hearth facilities.

A contributing factor to the present high production rates has been the continued expansion of electric furnace steelmaking. While the total steelmaking production of the country may show an increase of about 5 per cent over 1942 the electric furnace steel capacity will have increased about 25 per cent. Expressed in another way, about 25 per cent of the total increase in steel production can be attributed to electric furnace steel, and it appears that close to 5,000,000 tons will be produced in the course of the year. The actual capacity of the industry is even higher, since part of this capacity was put in operation during the year.

In the production of these large tonnages of steel the industry was compelled to make the best possible use of strategic and scarce alloying materials. This has been done (1) by the careful adjustment of steel analysis, as illustrated by the use of NE steels and (2) by the maximum use of alloy scrap as a source of alloying conditions. In 1943 approximately one-third of the alloy steels produced were NE steels, a step that is credited with saving 24,000 tons of nickel at a small cost in manganese and moly.

Another 10,000 tons of nickel was saved by careful attention to the recovery of the residual alloys in scrap. This has been accomplished by the vigilant segregation and re-use of alloy scrap despite the fact that scrap with two or three alloy components is presenting considerable difficulty.

Copper, Tin, Lead and Zinc

by Harold A. Knight
METALS AND ALLOYS

At least three of these metals were in the critical category, with only lead relatively abundant. Accordingly the chief aim of producers of these critical metals was to produce and produce, using mostly well established methods and types of equipment. There was no time for frills, finesse or refinement in processes.

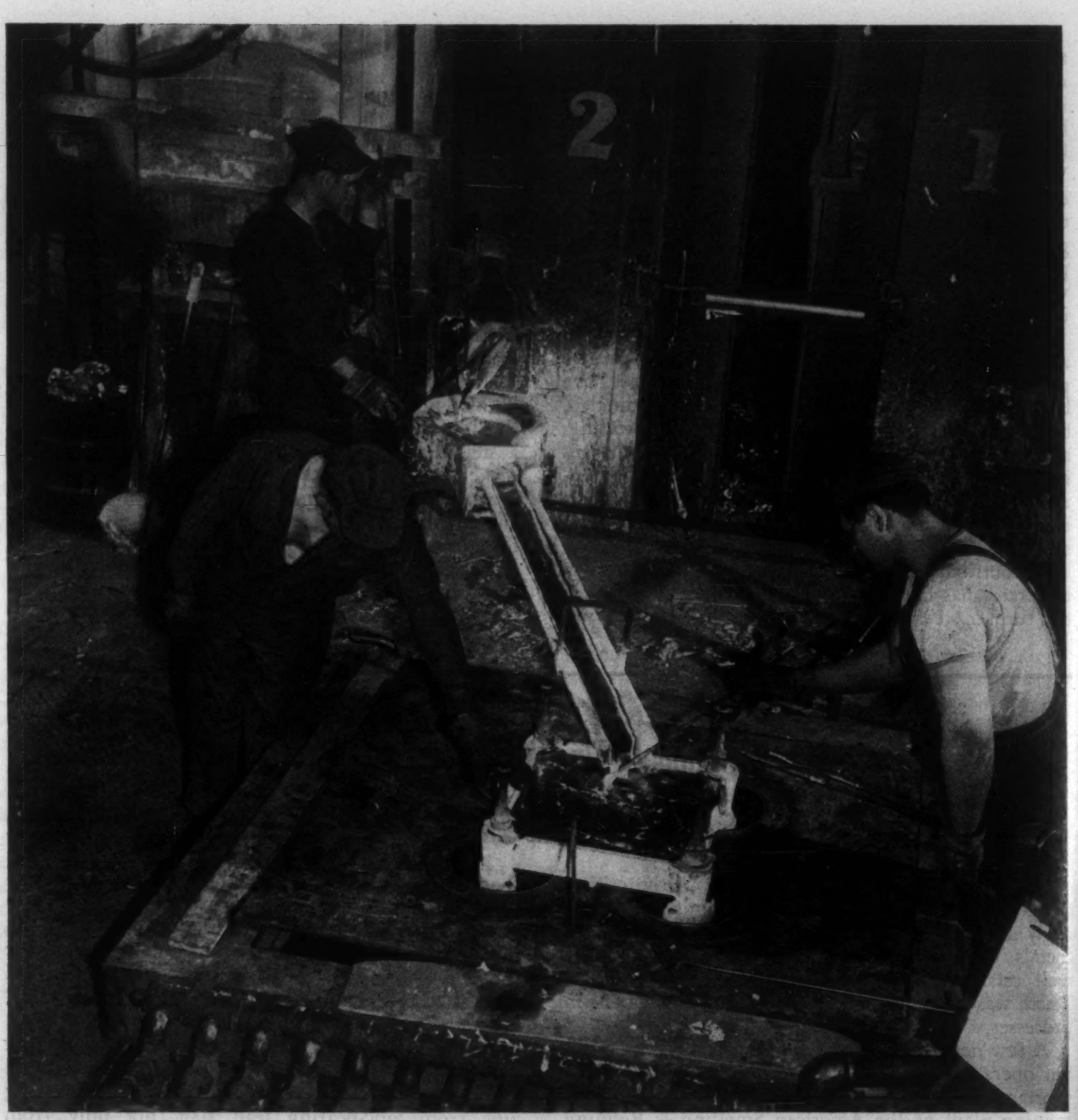
A few new smelting and refining plants were built but operations were often far from goals because of shortage of labor. Such was the case with the new refining plant of the American Smelting & Refining Co. at Amarillo, Texas, which has a capacity of 4800 tons per month but was operating on Dec. 1 at only half that rate on prime western zinc, the common grade. Again, towards the end of the year a plethora of high grade zinc materialized and there was no longer zest in production. The A. S. & R. Co. also put a new high grade zinc plant at Corpus Christi, Texas, in operation in September 1942, producing about 2400 tons monthly at the year's end.

The American Zinc, Lead & Smelting Co. remodeled the virtually abandoned Evans Wallover plant and put it in operation on electrolytic zinc—then the Government doubled its capacity.

In one instance, at least, an old but rather dormant process was revived. The New Jersey Zinc Co. converted prime western grades into high grade zinc by the vertical fractionating column method. Cartridge brass and die cast munitions parts demanded earlier in the year large tonnages of the "4-9's" (99.99% pure) zinc. However, when we became surfeited for the time being with small arms ammunition, around Nov. 1, the tonnage demand for high grade waned, as mentioned above.

Probably the only new development among the zinc-lead producers is that of the St. Joseph Lead Co. at its plant at Herculaneum, Mo., in recovering zinc from zinc-bearing lead slag, not only from current production but from slag piles accumulated these many years. Though this is a profitable operation apparently at present war prices for zinc, there is a question whether it will be a black ink enterprise in peace.

Statistics during a war are anathema—or were until recently when bars will be let down, according to Donald M. Nelson, since the tremendous figures may help scare the enemy. To date no figures on production of electrolytic and fire-refined ingot copper have been released. However, figures on brass mill production for the 12 months, ended June 30, 1943, showed a total of 5,223,779,000 lbs., or 2,611,890 net tons. There are no comparable figures since even in peace these statistics are not forthcoming. However, in 1941 output of refined copper was



Aluminum alloy being poured into a special fixture that feeds four molds, from which long cylindrical ingots are continuously withdrawn. (Courtesy: Reynolds Metals Co.)

1,065,667 tons; of slab zinc, 881,523 tons, totaling 1,947,190 which was not enough metal as raw material to take care of the June 1942, to June 1943, brass production. Remember, too, that by no means does all copper and zinc output go into brass making.

Virtually all agree that it is easy to pick tin's leading development, the production from the new Longhorn tin smelter on the Gulf of Mexico in Texas. Furnished with tin concentrates from Bolivia, this smelter turned out its first pig tin on April 5, 1942. It can now produce 50,000 gross tons a year, or the amount consumed in the United States in 1938. (In 1937 only 25,000 tons of the 208,000 smelted in the world came from Bolivian ore.) Built by the Billiton Co., experienced in tin engineering and commerce for many years, it is probably the most modern and best in the world and probably assures us enough tin, with careful consumption, for the duration.

It is constructed for handling all grades of tin from pure alluvial concentrates to the lowest grades of primary ores, the specific treatment depending on chemical composition and physical properties.

Secondary Metal Recovery

by F. W. Willard

President, Nassau Smelting & Refining Co.

Engineering developments in secondary metal recovery have been fundamentally indirect in 1943. In general, changes in the technology have been forced by the changing character of the scrap.

Under pressure of war, methods of collection and identification of scrap metal have improved so far as reduction of contamination is concerned. Emergency methods to augment tonnage have been forced. Some of these are uneconomical.

Recovery of nickel and copper from nickel silver scrap in a form suitable for fabricating cupro-nickel tubing have been undertaken as an emergency project. It is doubtful that the method can survive economically.

Recovery of copper, zinc and steel from gilding-clad steel scrap has been started using the classic cupric-ammonium-carbonate leach technique modified to suit the form of material treated. This may have survival value.

Copper-bearing scrap ordinarily available to the secondary processor of foundry brasses and bronzes has so changed in proportion of demolition to process scrap that ingot makers have been compelled to make important changes in their formulations.

Secondary zinc has decreased in volume on account of diversion of zinc to ordnance copper-bearing alloys greatly disturbing the normal usages.

An old practice of treating low grade copper-bearing scrap by the blast furnace, producing black copper for the custom smelters and electrolytic refiners has been modified successfully in some places to produce a satisfactory red brass base by closely controlled charging. This base is subsequently reverberatory-refined to standard specifications. This method should survive.

The excessive supplies of aluminum bearing scrap cry aloud for the development of a method of tearing the alloys apart to recover the pure metals. Little progress in that direction is reported.

Modifications of the highly developed methods of detinning have made possible the use of existing detinning facilities to recover acceptable tin and steel from used tinned containers, but the collection of the containers has not been sufficiently successful to utilize all of the available detinning capacity.

The exigencies of war have not generally demanded new developments of method and equipment to meet the production load imposed. Such developments as have been made were incidental to expansion of existing facilities, which have not been extensive because the secondary metal industry was, if anything, overbuilt for average peace-time activity.

Tapping an open hearth furnace at a plant of the Bethlehem Steel Co.

Aluminum and Magnesium

by H. E. Bakken

Associate Director of Research,
Aluminum Co. of America, Pittsburgh

Virtually all the technical developments in the production of aluminum and magnesium are related to the expanded consumption requirements of wartime and to countless new applications in specific products.

A survey of the aluminum industry for 1943 discloses a number of significant developments. One, is a new process for obtaining alumina from low-grade ores. Another, the production of new aluminum alloys with materially improved tensile strength —designed for immediate wartime aviation use. A third—the result of several years of research and indispensable in the war effort—is the application of an ingot casting method which permits the production of sound aluminum ingots of large size, for conversion into the large sections of aluminum sheet, plate, forgings and extrusions.

Present reserves of domestic, high alumina bauxite are rapidly nearing exhaustion and a great deal of energy has been expended on methods of obtaining alumina from low grade bauxite of which the supply, though limited, is far greater than that of high grade.

Prior to the war, all of the alumina produced in this country was obtained by the Bayer process. In this process, about 1 lb. of alumina and 1 lb. of soda are lost in the red mud residue with every pound of silica contained in the original bauxite. This made it uneconomical to process bauxites high in silica. The new process of the Aluminum company takes the red mud residue of the Bayer process and after adjustment of its composition, puts the residue through a sintering process. From the sinter, both alumina and soda formerly lost are recovered economically. The practical result is that substantial tonnages of bauxite, hitherto disregarded as a source of alumina, can now be made available.

Throughout the war period several large scale government sponsored investigations, conducted by able investigators have been carried out, utilizing raw materials other than bauxite as a source of alumina. These include clays, alunite, and anorthosite. Real progress has been made.

Although details of alloy compositions and properties cannot now be revealed, new aluminum alloys have been developed which will play an important part in aircraft construction. Tests by both private industry and the Army and Navy show that use of these new aluminum alloys will help materially to make our bombers and fighter planes faster, and carry heavier loads.

The tremendous expansion in the aluminum industry during the war has brought to the fore a development in casting ingots for working, which has been under way for several years. In this method, molten metal is poured at a controlled rate into a mold shell where initial freezing begins. The ingot is continuously withdrawn from the shell— solidifying and cooling as it lengthens. The ingot may be cut to any convenient length. These huge ingots can be rolled into continuous strips of metal more than a city block long, for conversion into wing and fuselage sections of bombers and fighter craft. This ingot casting process is also used in producing wrought magnesium products.

A most important factor in maintaining wartime production of planes and other armament, has been the ability of the aluminum industry to keep abreast of all demands. At no time in the past two years has war production been slowed down because of lack of vital aluminum, and at the present time our country's production capacity of more than 2,000,000,000 lbs. per yr. is considered ample to meet all demands of our armed forces.

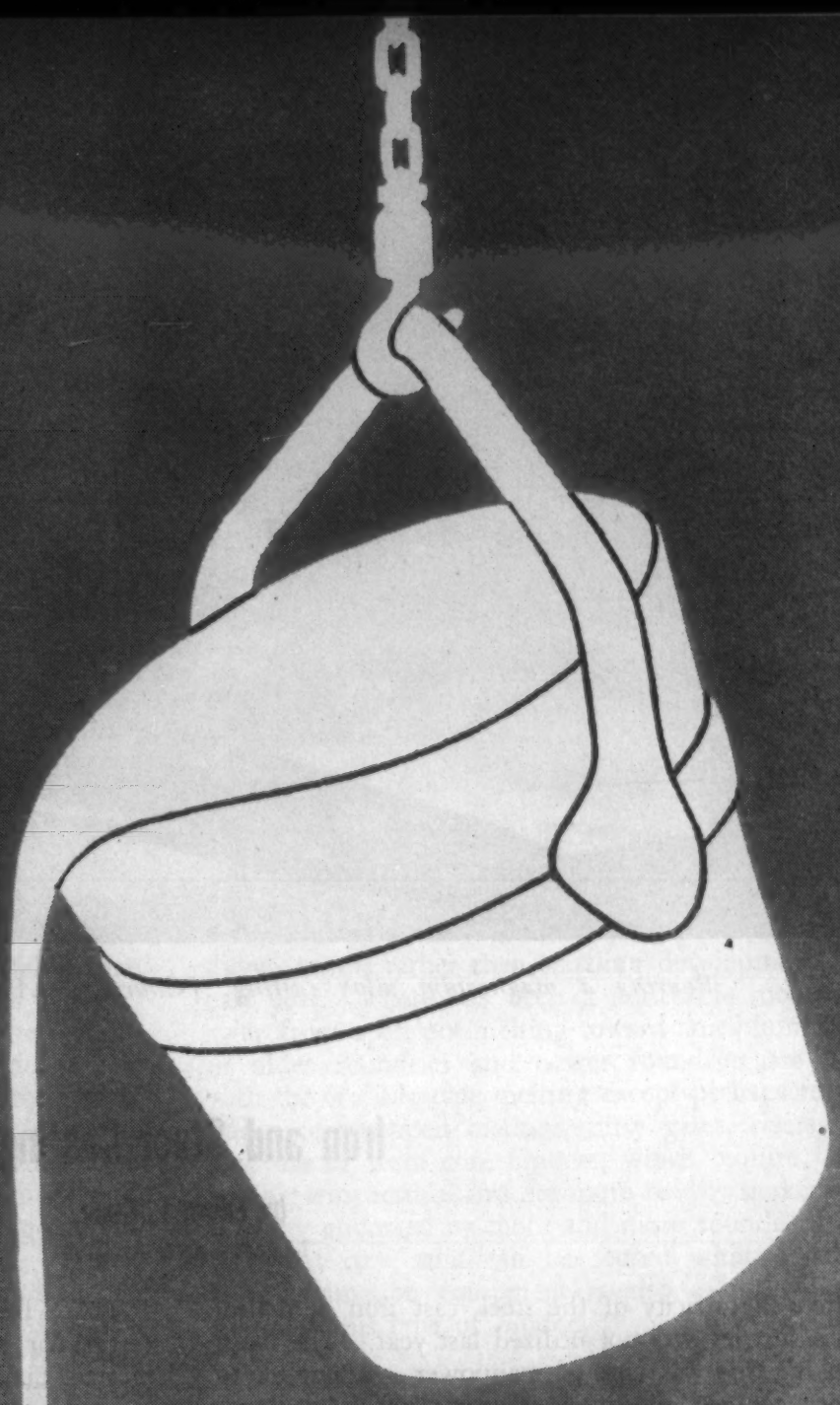
Our magnesium production today exceeds in tonnage the production of aluminum before the war. The 1939 trickle of 6,000,000 lbs. a year has grown to a torrent. Today's magnesium production has increased perhaps a hundredfold.

To meet these heavy demands, magnesium is now being produced by three different processes and by about a dozen companies. One group of processes produces magnesium by the electrolytic reduction of magnesium chloride. The magnesium chloride is produced in various ways from such raw materials as brine, sea water, magnesium salts, and from magnesite. The other processes depend on direct reduction of magnesium oxide—one using carbon, another ferro-silicon as the reducing agent.

The costs of these processes naturally vary, but the use of all of them is justified at the present time by the vital needs of the war.

Improvements in fabricating techniques have kept abreast of expanding production. Important among these has been an improved chemical stability of alloys, made possible largely through more careful control of their purity. It has been found, for example, that if the iron content is controlled to very close limits, corrosion resistance is materially increased. Some of the present magnesium alloys are far more resistant to corrosion than the earlier alloys. Since protective coatings and paints are always recommended on magnesium equipment subject to severe exposure, still greater permanence is realized.

All of our nation's magnesium is now earmarked for war use. Many foundries and manufacturing companies are becoming familiar with the handling of this newest member of the family of light metals. This augurs well for an increased use of magnesium by industry in the post-war period.



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Foundry Practice.....

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Pouring a magnesium alloy casting. (Courtesy: American Magnesium Corp.)

Iron and Steel Castings

by Edwin F. Cone
METALS AND ALLOYS

The full capacity of the steel, cast iron or malleable industries was not utilized last year. The main cause for this was lack of manpower. About 80 to 85 per cent of the steel casting capacity was employed. The malleable casting industry was short 10,000 to 15,000 men whose addition would have enabled it to produce about 30,000 additional tons each month.

Steel Castings.—A few only of the developments in the steel foundry industry can be made public. One of the most interesting of these is the preparation of test data on the NE steels and it is not unlikely that, within a year or so, standard NE compositions for steel castings will be in use.

Centrifugal castings of steel have made decided progress. Those foundries that have been making experiments with single units are now installing many units. One large foundry in the south now has 72 horizontal axis casting machines and 32 vertical axis machines.

The quenching heat treatment of steel castings has received much more serious attention and a great many foundries are now using these methods as a daily procedure.

The production of cast steel armor plate has expanded and is an important contribution to the war effort.

Other developments include expanding use of Magnaflux testing, the use of organic binders other than corn products, and studies on sands and cores at elevated temperatures.

There has been greater use of the sideblow converter for steel castings with decided improvement in steel quality. The use of the converter in triplexing with the electric furnace has expanded, a notable example being Ford's new foundry.

Gray Iron Castings.—Cast iron has had difficulty in finding its place in the war program—some foundries had to shut down or convert to the production of steel or magnesium castings. There have, however, been some rather notable developments in the application of cast iron for Ordnance. Here it is satisfactorily replacing other critical metals but is also finding use because of its own characteristic properties.

For example it is performing satisfactorily as crankshafts in diesel engines. Substitution of cast iron for steel in various parts of machine tools has been a prominent development the past year.

More interest in processed iron for high strength requirements is in evidence and the gray iron industry is reported as becoming thoroughly alive to the possibilities of processing methods.

Malleable Iron Castings.—Due to the lack of sufficient manpower the malleable iron industry last year operated at only about 70 to 75 per cent of capacity. Some reasonable increases in equipment have been, or are being made at certain plants. But a substantial additional requirement remains which can only be met by the release of manpower.

Considerable effort has been expended to improve efficiency and to eliminate bottlenecks in some plants.

Pulverized fuel has been applied in some plants where it was not already in use in melting and annealing equipment. Increased mechanization has been introduced where practicable. Demand for large malleable iron rear axle housings has been and is heavy and some plants have increased, or are increasing, their production facilities to make these.

There has been an increasing use of malleable castings in armament production but, as already stated, lack of manpower has interfered with production. The use of co-belligerent Italians in this country is being considered and it is hoped that such release of manpower will make it possible to meet all demands and to fill all armament requirements.

Magnesium and Aluminum Castings

by R. E. Ward

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The tremendous increase in aircraft production has been responsible for an equally rapid increase in the production of aluminum and magnesium castings. During the first part of 1943, there threatened to be less aluminum alloy ingot available than required, which necessitated immediate steps to segregate scrap aluminum and to establish credited smelters and refiners for reprocessing scrap into useful ingots whose composition met the governing specifications. Experimental work had been conducted on secondary grade aluminum alloys and several government specifications, which were issued in the middle of 1942, found wide applications during the past year.

Magnesium alloys remained the same and to date there are no secondary magnesium alloy specifications for aircraft quality sand castings. However, the early shortage of aluminum necessitated consideration of the use of magnesium wherever possible. A great deal of experimental work has been completed and additional work is continuing to determine the effect of impurities and various stresses on magnesium alloys. There is also considerable discussion at present on the relative merits of the two commonly used sand casting alloys and it is quite probable that the near future will see a standardization on one sand casting alloy which will do much to facilitate production in the foundries.

Aluminum foundry practice has improved very gradually in the past several years. The basic principles set down have remained essentially the same. However, the introduction of low frequency induction melting in the aluminum foundry is a new practice and although there are not very many available data at present, it appears that this process may be very satisfactory in foundries where continuous melting is employed since the possibilities of encountering so-called pin-hole porosity in castings as a result of gas absorption during melting is claimed to be eliminated. Investigation work is being carried on with methods of degassing aluminum alloys both here and abroad.

Zinc-magnesium-aluminum alloys requiring no high temperature heat treatment have found numerous applications where the warpage of the casting due to the high temperature heat treatment was troublesome and where it was desired to obtain physical properties in the casting equivalent to the regular heat-treated alloys.

Recommended magnesium foundry practice has also shown trends rather than startling developments the past year. There has been a noticeable movement away from open pot melting toward crucible melting in older foundries and newer foundries are built with the crucible type melting except perhaps for refining of scrapped castings, dirty gates, risers, etc. The use of resin core binders, which require lower baking temperature and are more readily shaken out, is being endorsed by more and more foundries. The fact that core sand can be reused without expensive reclamation equipment is also a big point in favor of this type of binder.

Pouring crankshaft castings of copper-silicon alloy steel. (Courtesy: Ford Motor Co.)

Inert atmosphere arc welding of magnesium castings for repairing defective castings has recently been studied closely. A standard process specification for this type of work will be forthcoming.

With the tremendous amount of experimental work being conducted on light metals, it is expected the next year will show improved alloys, protective surface treatments and heat treatments which will make an even broader field for the light metals.

Brass and Bronze Foundry Practice

by William Romanoff

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While government officials have stressed mostly the speeding up of quantity production to help arm the fighting forces, there has apparently been no let down in the quality of castings made by brass and bronze foundries. This was accomplished in spite of the fact that most foundries are making castings and using alloys that are totally foreign to their peace time production.

Most castings are today being made from brass and bronze ingots manufactured from available scrap, with little or no copper, tin or other strategic materials added. This was accomplished by the adoption of emergency specifications, which in some cases were more adaptable than the original specifications and will no doubt be continued after the war. As the trend of available scrap changed, the specifications were changed accordingly and, to the credit of the foundries, it must be said that they cooperated beautifully considering the difficulties encountered with constant change.

As uncommon as test bars were before the war, they are that prevalent now. Practically all government castings—which practically means all the castings being made at the present time—require test bars that will meet specified physical properties. To obtain these properties, in fact, physical properties considerably higher than specified, has necessitated research on the proper type of test bar, furnace atmospheres, pouring temperatures, gating, etc. To say that this work on test bars has definitely improved the quality of castings is certainly no overstatement.

In line with furnace atmospheres, the furnace people have contributed their share of improvement. While no radical change in furnace design has been noticed, still slight changes have been made to speed up melting. Automatic mixing of fuel and air are aiding in furnace atmosphere control. Here and there, one observes high-frequency furnaces in production melting to take their place with the more common low-frequency induction and arc type electric furnaces.

Decidedly new is the considerable change-over from green sand molds to dry sand molds made from various core mixtures. This, together with the numerous new core and mold washes, has had a tendency to improve the surface of castings. Sand conditioning and testing are very important factors in elimination of most casting defects, and during the past year, it seems that foundries are more conscious of this fact than ever.

It seems that castings have increased in size so that considerably more roll-over molding machines are being used at the present time than normally. This can also be said of sand slingers which were seldom used in brass foundries.

Any equipment that can save labor, with the present shortage, is at a premium. This accounts for the present usage of infra-red lamps for drying of green sand molds. Whether they are more efficient than the old torch drying methods is debatable, but they are supposedly 75 per cent labor saving.

Plaster molding and centrifugal casting have gained considerable headway, the latter particularly in aluminum bronzes and manganese bronzes.

Manganese bronzes, unheat-treated, with a minimum tensile strength of 110,000 lbs. and minimum elongation of 12 per cent, are common and aluminum bronze castings can be heat treated to obtain tensile strengths of approximately 130,000 lbs. In some instances this practically makes them competitive to steel castings. Incidentally, manganese bronze, from a peace time figure of less than 1 per cent, has skyrocketed to a production of between 20 and 25 per cent. Silicon bronzes have fallen by the wayside due to the fact they require from 80 to 90 per cent of copper in their manufacture, and there has been too great a shortage of this latter strategic material.

Brass foundries in the past have been hesitant about making the high strength castings because of the difficulty of cutting off the large gates and risers required. This fear has been eliminated and the process simplified by the new high speed refractory cut-off wheels.

In general, the brass and bronze foundries have been called upon to assume a terrific burden, and it can be said that they have met their responsibilities in a manner that they can be proud of and that they have solved, through hard effort, problems that will assist them materially in the coming post-war period.

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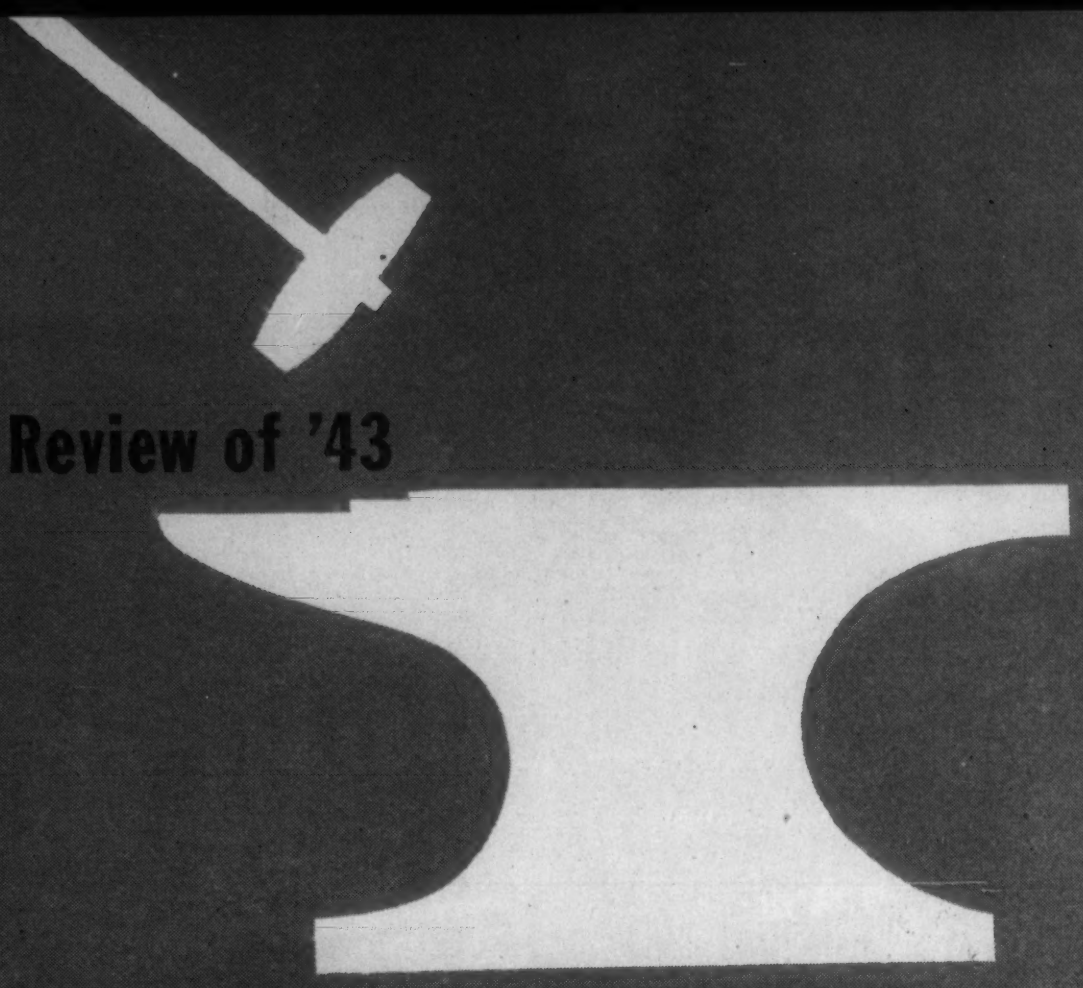

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Electrical induction unit brazing adapters to 75-mm. chemical shells. (Courtesy: The Ohio Crankshaft Co.)

Heat Treatment of Steels

by Gordon T. Williams

A useful theme for this discussion on developments and trends in heat treatment of steel has been provided by J. W. Bolton in his recent AFA Foundation Lecture ("Foundry Metallurgy in the Castings Industry"):

"It is interesting to note that emergency development of the NE steels has done much to offset inertia on the one hand and 'overselling' on the other in wrought steels."

Much of the inertia which had to be offset arose from the "heat treat." In many a shop and industry, equipment and methods had been before the war adequate only because steel could be purchased of such a grade or alloy type that deficiencies in treatment were counterbalanced by excess hardenability. Then came alloy restrictions and NE steels. Plants whose facilities and procedures were seriously inadequate found themselves in trouble, because establishment and acceptance of the NE grades came from committees whose consumer members represented the better informed, better equipped companies. These committees then approved application of alloy grades which were adequate if properly handled, but without the leeway formerly available to offset inferior heat treatment.

Add to this the fact of sub-contracting which put work into plants unused to modern high-production heat treating in direct quality competition with the best processors — there was a tremendous pressure on every one to come up to the level of the best. Intensive education, through the medium of the technical press, the engineering societies, producers, and industry integration committees has produced the required result. The post-war implications are that heat treatment will be used to an extent and on a quality level heretofore unbelievable.

The basic elements of heat treatment — time, temperature and rate of cooling — are today well in hand. Furnace equipment has been developed to do well nigh any job with a high degree of reproducibility. The vital effect of furnace atmosphere on cooling rate in quenching has led to ever-increasing use of furnaces with controlled atmospheres; in fuel-fired equipment the radiant tube type has assumed the leading position. This has brought with it a better understanding of what an atmosphere has

to do and be, and generators are now available to produce just about any combination of gases that may be required. Costs per cubic foot seem to be fairly well stabilized and it appears that no great downward movement can be hoped for. The use of atmospheres for steel treating operations will always be a substantial item of expense but will to an increasing degree be recognized as a money-saving expenditure which pays large dividends.

Induction heating has spread like wildfire. Overenthusiastic promotion has resulted in some unjustified applications but, everywhere it is used, consideration is being given to post war use on peacetime products. The cleanliness, the (pardon the word) miracle of induction heating have a universal appeal and lead to general interest. The amount of equipment now in use is small compared to a possible saturation point, but is nevertheless large enough to pose a serious problem to equipment producers.

It appears to me that their problem will be that of insuring conversion to normal applications, that they will have to work hard and fast on the fixture end of the business, and on educational work. There are mighty few shops which could not make use of an induction heating outfit, and a surprising number could economically justify purchase if a thorough study were made of possibilities. The higher frequency units will probably prove more popular for miscellaneous work because of the ease with which inductors can be made.

Salt baths, too, have gained a new foothold during the war production period. They have been too zealously promoted at times and have been put on jobs better done by other methods, but their obvious advantages in speed and accuracy insure that equipment, particularly of the internally heated type, will stay in use after the war.

To return to the earlier theme, one of the most serious shortcomings to be found in heat-treating departments is in quenching methods. Here, rather than in furnace equipment, is where most failures with NE steels occurred, in my opinion, and here was the biggest reason for earlier use of excessively alloyed steels. New quenching oils have been developed lately to give faster cooling, hence better hardening. A new method of quenching called "Martempering" is available to use the cooling rate of water without the accompanying hazard of cracking, and promises to become an important standard procedure.

In most cases, however, a thorough study of factors affecting quenching has shown the way to improved heat treatment without necessity of new heating equipment. Better control of coolant temperature, stronger and more directed circulation, and provision for getting each piece uniformly quenched have solved most of the problems which have arisen when the lower alloy steels failed to heat treat properly in one plant while successful in others. It is to be hoped that this lesson will stay taught; if so, it will stand as another great gain from the war production experience.

Furnaces, Refractories, and Fuels

by M. H. Mawhinney

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The close of the present year also marks the completion of the period of intensive industrial construction necessitated by the War. Operating experience with the equipment built in this period is not yet available in any large quantity, but will be the contribution to be expected from the next year, 1944. The characteristics of war development are plenty of money but little time, and the results are both good and bad. Successful ideas are developed much more quickly than in normal times, but many unsuccessful schemes are tried without proper consideration.

In the field of industrial heating furnaces, the past year was not marked by any particularly revolutionary invention, but was one in which many very interesting installations have been built. In addition to the improvement of most of the old furnaces to increase their capacity and efficiency, an amazing number of new installations have been built. Many of these have been unusually large, both in number of units involved and in the size of individual furnaces.

Examples of this development include batteries of hood furnaces for atmosphere annealing and using alloy retorts of increased size; giant rotary hearth furnaces to heat billets for the forming of war products; continuous radiant-tube-fired furnaces for the annealing of tubes and bars in long lengths and without scaling; automatic heat-quench-draw installations for munitions; and many others.

The number of forced convection furnaces continues to increase, because these furnaces have conclusively proved their value at temperatures below 1300 deg. F., and have been a valuable contribution to the heating of steel products as well as to the treating of aluminum and magnesium. A current discussion of the value of forced convection at higher temperatures will be decided only when more data have been developed.

Another controversial question involves the subject of radiant combustion, with much talk of infrared rays, and comprising the use of a multiplicity of radiant cup burners located close to the heated material. The accumulation of data from many furnaces built on this principle this year will assist in defining the applications where this method can be used to advantage.

The impetus gained by induction heating in the manufacture of shells has carried it into other fields, and installations of important interest include the continuous annealing of stainless steel tubes and the heat treatment of alloy steel bars in long lengths.

Salt bath furnaces, with a large number of new electric installations, continued in popularity for the decarburization-free hardening of high speed steels and extended their applications to other fields of special utility. The close temperature and "atmosphere" control possible with the most advanced equipment suggested their use for many ticklish NE steel-treating jobs, and some interesting applications were developed for the isothermal hardening without distortion of precision ordnance parts.

The development in the control of furnaces has been largely in the improvement of instruments for this purpose. Of outstanding interest is the use of electronic and other electrical principles to eliminate the inertia of mechanical moving parts and increase the sensitivity of the instruments. The development of the radiation pyrometer for high temperatures and for fast temperature determination has also made progress in the past year.

In the field of refractories for industrial furnaces, the insulating firebrick continues to be the outstanding contribution to the saving of fuel and the increasing of production. This type of lining continues to be adapted to all possible applications for these reasons. Interesting and successful installations of monolithic linings of plastic refractory have been made in large furnaces.

The shortage of fuel oil and natural gas spurred the development of anthracite gas producers and of equipment for the combustion of pulverized coal. These developments will have a permanent effect on fuel engineering in the future, when better use of the more abundant fuels will continue to be necessary.

It is evident that in the industries which must quickly supply war materials in large amounts, the war years are marked by the courageous application of known principles rather than by new inventions.

Nonferrous Alloy Heat Treating

by A. S. Henderson and B. W. Gonser

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Conversion of the makers and users of nonferrous metals to war production has been completed, and production and improvement of the weapons of war is now the big job of these industries. This condition has permitted the technical staffs of most companies in that field to function in the normal manner, and, because of the increased pressure of war, developments have been released to the manufacturing groups much earlier than would be the condition in time of peace. Furthermore, a similar situation exists with the furnace manufacturers, and improved furnaces should shortly be available.

Because of the excellent fatigue strength of beryllium-copper alloys, many applications now using steel springs are being examined for possible change to a beryllium-copper precipitation hardening alloy. The remarkable progress of this alloy has, in no small part, been promoted by continued research into the alloy composition and proper heat-treating technique. Research into the low temperature heat treatment of cold worked brass and bronze has developed products which in some instances have been substituted for beryllium-copper alloys, thereby easing the rather acute beryllium supply problem.

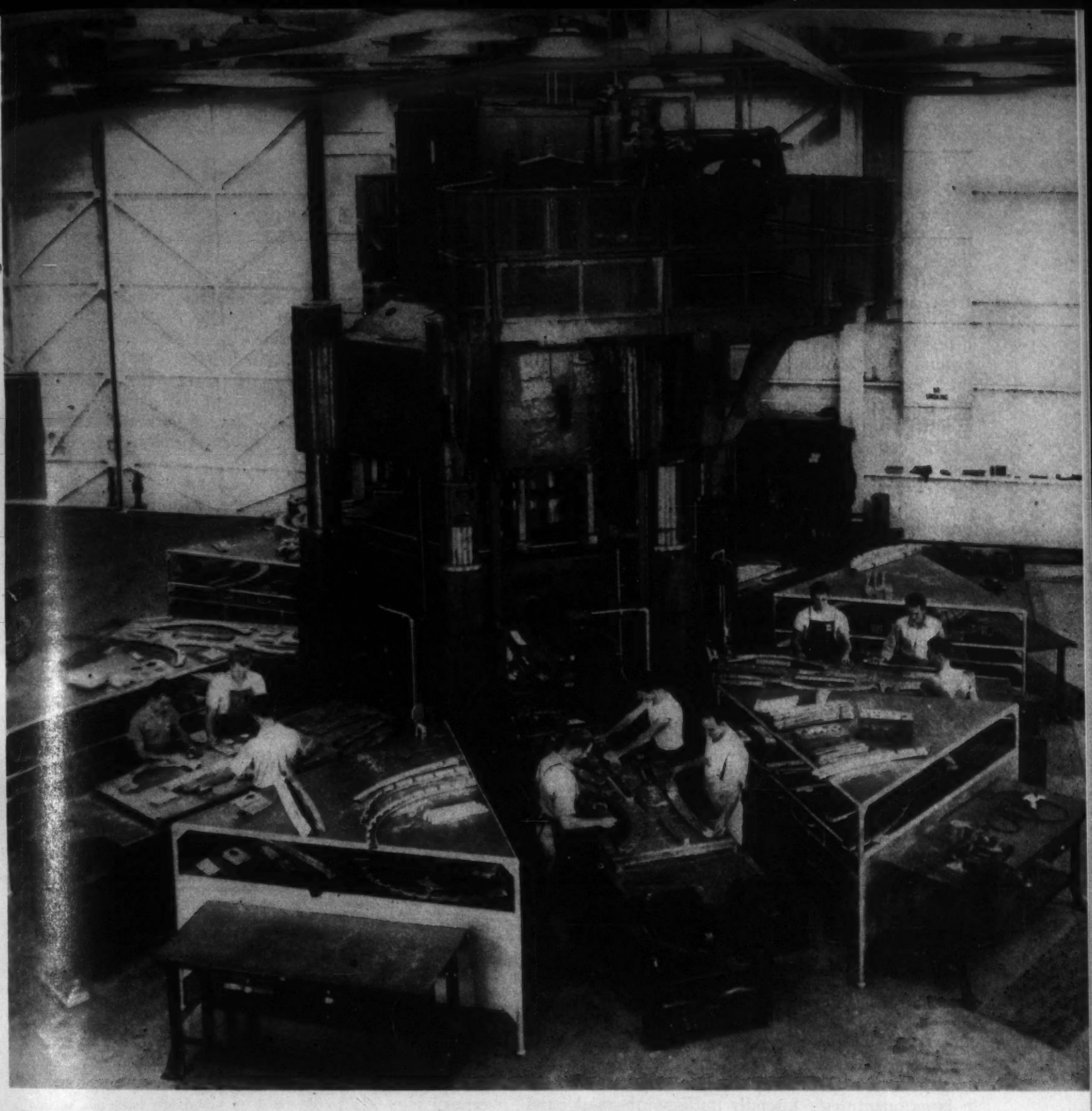
Further development into the age-hardening characteristics of the aluminum bronzes has opened new applications for this alloy in various industries. As in all age-hardening alloys, the heat-treating procedure must be adopted to a carefully controlled alloy composition and, when this fact is recognized, there is little difficulty in obtaining reproducible results.

The solution treatment for age-hardening aluminum alloys has been performed on a very large scale in the aircraft industry and the majority of the large furnace installations are working satisfactorily. There has been considerable discussion on the artificial aging of the high zinc-aluminum alloys, but this practice has not found favor in this country; consequently, it must await post-war development. Aluminum has remained in short supply throughout the past year, which has restricted new applications.

Because of the very limited solubility of many of the common metals in magnesium, the development of hardenable alloys has been rather slow. The development of additional alloys of this metal is now receiving considerable attention, however.

Annealing of the nonferrous metals has been mainly a production problem during the past year with many large furnace installations being completed. The demand for some of the uncommon metals, such as tantalum, molybdenum, and tungsten, has been such that an unusually large number of vacuum, molybdenum-wound hydrogen, and induction furnaces have been installed for heat-treating work.

The flowing of electroplated tin plate, although not heat treating in its limited extent, was a major development during the year. This has involved high frequency induction heating and direct electric resistance heating, particularly. Diffusion of electroplated metals by heat treatment (indium coatings, for example) is also becoming increasingly important in the development of special surface conditions.



Forming aircraft parts on a versatile 2500-ton, 6-die slide hydraulic press, using rubber dies. (Courtesy: E. W. Bliss Co.)

Press Forming

by John J. Feeley

E. W. Bliss Co., Brooklyn, N. Y.

The capacity production required by Government War Arsenals has been responsible for important development in the press industry during the past year, but because of the war, much of this advance has not been released to the public.

War production did not progress far before the costs involved in producing large quantities of ordnance parts by machining, casting and forging were found to be extremely high. Subsequent experimentation revealed that in many cases these parts could be made more satisfactorily and much more economically on mechanical and hydraulic presses. Sizing operations now performed on mechanical knuckle joint presses, instead of slower machining, are an excellent example of an operation previously considered impossible on a metal working press.

There are many such examples and this added utility for the metal working press should be of considerable help to manufacturers in the post-war era.

Equally important is the press industry's development of equipment suitable to the flexible requirements peculiar to the diversified production in the aircraft industry. It is a well-known fact that the frequency of design changes in airplane manufacture ran costs into prohibitive figures due to the necessity to making-over expensive dies. Now ground plate blanking dies, zinc and zinc-aluminum dies, wood and masonite punches and the rubber die process have all aided in supplying the aircraft industry with the needed flexibility of production.

The rubber die process mentioned above eliminates the necessity of a mating die as pressure is exerted against the rubber and punch, or group of punches. The 2500-ton six die slide hydraulic press is an excellent example of a rubber die application. These giant presses are at top production stamping and forming miscellaneous airplane parts. Twenty-four loading operators working continuously on each automatic press maintain maximum production.

The material handling features developed have been quite varied. Dial feeds have been adapted to cartridge case redraw work on mechanical presses and dial feeds have been provided for marking and coining presses on both mechanical and hydraulic designs. On heading or coining operations, automatic cyclic operation is available. Transfer feeds are available on mechanical and hydraulic presses for cartridge case work and also for forging work.

Production quotas on ordnance work during the past year have warranted the installation of a considerable amount of automatic press equipment. Complete units consisting of feeds, shears, ejectors, knockouts, die cushions, etc., eliminate the high labor costs so objectionable in many areas. Installations of such equipment require one operator to keep an eye on a battery of six or eight machines. Every indication is that the next decade will find automatic equipment in greater demand.

On the press design itself, development has been along the lines of longer stroke mechanical presses equipped with the drag link or uniform motion mechanism to provide an even speed on the draw stroke with quick return, thus obtaining on press structures a drive similar to a shaper or planer drive on machine tools and greatly extending the range of stroke over which a mechanical press can operate.

The hydraulic design trend has been in two directions, toward heavier, self-contained presses as witnessed by the 5000-ton presses with 12 ft. between the rods and also to faster presses, particularly on long stroke, light tonnage designs where advance and return speeds up to 2000 in. per min. and pressing speeds up to 800 in. per min. are available.

Limited space prevents further discussion of the developments of the press industry. However, it is pleasant to look forward to the post-war period when these developments can be incorporated in peacetime pursuits.

Powder Metallurgy

by Phillip R. Kalischer

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Under the stimulus of war demands, the application of powder metallurgy has progressed beyond the expectations of many of its proponents. Much of the demand arose from the need for high strength and consequently high density components of ordnance in large quantities. Literally millions of small parts of high strength and high density are being made to meet the armament tempo.

A critical shortage of machine tools forced manufacturers to look for new methods of making parts. Shortage of some materials required substitution of less critical metals. The high scrap loss associated with many machining operations created a serious burden, both as to procurement of stock and disposal of scrap as well as increasing manufacturing costs. And with all this the cry for speed on the production front conspired to skyrocket powder metallurgy towards the front line of manufacturing methods.

But something more than demand is necessary for a new manufacturing process to achieve production status. Many factors contributed to this achievement, but most important perhaps was increased knowledge and experience with the forming of iron powders which was acquired both in the laboratory and shop. For success in forming high density compacts, however, much credit is due the manufacturers of iron powder who made available high purity, low cost powders with outstandingly good molding properties.

Credit must also go to the designers and builders of furnaces capable of working at temperatures up to 1500 deg. C. (2730° F.) on a production basis. Improved gas atmospheres played their part by making available satisfactory controlled atmospheres for sintering furnaces.

Some unusual results have been achieved in forming tiny parts at astonishingly high speeds in mechanical presses and of shaping very large parts to excellent tolerances in hydraulic presses. The availability of higher forming pressures has boosted the engineering properties as well as the density of powder metal parts.

A year or so ago, a high density part in commercial production ran 60 to 70 per cent of theoretical density. Today parts running 90 per cent of theoretical density and higher are standard production

A powder-metallurgy press producing carbide tool shapes at the rate of several hundred per hour. (Courtesy: Carboloy Co., Inc.)

items. This has been achieved not only by using higher forming pressures but with higher sintering temperatures as well, though often at the expense of die life. Hot pressing is making only slow progress.

Hardenable steel parts that formerly were a rarity are made in large quantities today as a result of our increased knowledge of carburizing atmospheres. It is possible today to make plain carbon and alloy steels from metal powders that are competitive in many applications with wrought steels of the same composition. Structural parts are now being made in production from these steels.

In the field of substitution of metals, powder metallurgy has done its part. Alloys with the same operational characteristics as copper, for example, have been developed that may free thousands of tons of this critical metal annually by substituting more plentiful and far less critical metals.

No review would be complete without some mention of the newer alloy powders that are now available. Stainless steels, particularly the 18 Cr, 8 per cent Ni types, are now available commercially. The cost of these powders is still high, but for many purposes the savings achieved by the use of powder metallurgy more than compensate for the higher material costs. Some brasses are now available in powder form and are in fairly wide use. Certain of the so-called rare metals are becoming commercially available and we may look for outstanding developments through their use.

Thus in the passing parade we see that powder metallurgy is approaching maturity and has taken a significant place on the war production front. It still, however, receives an undesirable proportion of publicity based on airy claims rather than performance, and still requires considerable coordination between the practical manufacturing and research activities in the field, since the art still leads the science.

Forging

by Charles L. Tutt, Jr.

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The past year has seen many changes in forging practice and methods as a result of the ever increasing number of new forging machines that have been put into use. New techniques for forging steel and especially the lighter alloys, aluminum and magnesium, have opened new applications for the use of forgings. Probably the most interesting developments have taken place in the field of press forging, where new machines of greater size and capacity, as well as the necessary forging technique and die design, have been developed and put into use.

The principal developments in hammer (drop) forging have been a reduction in required tolerances and draft angles wherever there have been new or modern hammers in use. With the war effort requiring an increasing quantity of aluminum and magnesium drop forged parts, production capacity of the hammer forging facilities were inadequate. It is not possible, with the same equipment, to produce as many aluminum or magnesium drop forgings as similar steel forgings. Also a similar aluminum or magnesium forging requires a larger sized hammer than the steel forging.

New and larger hammer forging equipment has therefore been needed to fulfill the production requirements of the hammer forging industry. Where this new forging equipment is being used, the "Regular Close Tolerances," as specified by the Drop Forging Association, can be held. It is not uncommon to find draft angles as low as 1½ deg. with a maximum practice of about 7½ deg. for very intricate forgings.

In the field of upset forging there have been many outstanding developments, most of them in forging technique. Many new and difficult forgings have been produced in both steel and non-ferrous alloys, particularly aluminum and magnesium. Probably the outstanding development of the year has been the

commercial upset-forging of the intricate aluminum cylinder head (conventionally a casting) for radial aircraft engines. Cylinder barrels are also being upset-forged. A significant trend here is that upset-forgings much larger than were formerly possible are now being made, and large upset forgings can be expected to be important in post-war design.

Press forging has probably enjoyed the greatest expansion and progress in the past year of any of the forging processes. Little development work had been done in this field, as although it was known to be an excellent method for forging the non-ferrous alloys, the amount of this type of forging was small prior to the war. At the start of the war it was impossible, due to manufacturing facilities, to obtain sufficient drop hammers and upsetters to meet the forging requirements. Therefore many forging companies started to develop new techniques for press forging.

This has resulted in press forgings competing directly with both hammer and upset forging not only in the field of non-ferrous but also in steel alloys. Many forging manufacturers are also predicting that press forging will compete directly with both drop and upset forgings in the post-war period. Hydraulic forging presses of 5000-ton capacity are in use and 2000-ton hydraulic forging presses are quite common, while mechanical forging presses weighing 360,000 lbs. are also being used.

It has been found that it is possible to hold press forging tolerances as close and in many cases closer than drop and upset forgings, while on similar hammer and upset forging parts there are indications that press forging results in improved die life. As in the case of upset forging, probably the outstanding development in press forging has been the use of the latter for working the aluminum cylinder head for radial aircraft engines.

Die Casting

by Herbert Chase

There has been no more important development in the die casting industry in recent months than steps taken to control the quality of the die castings produced. This has come about largely because of the exacting demands of castings for military and naval applications. Some of the castings now being produced have to undergo 100 per cent X-ray inspection, and a great many more at least a 10 per cent inspection in radiographic equipment.

Proper venting and gating of dies is, as always, of the utmost importance in the production of sound castings and the wider use of X-ray equipment, including the fluoroscope, makes it far easier than formerly to determine when soundness is attained and also what effect changes in gating and venting have on the production of sound castings.

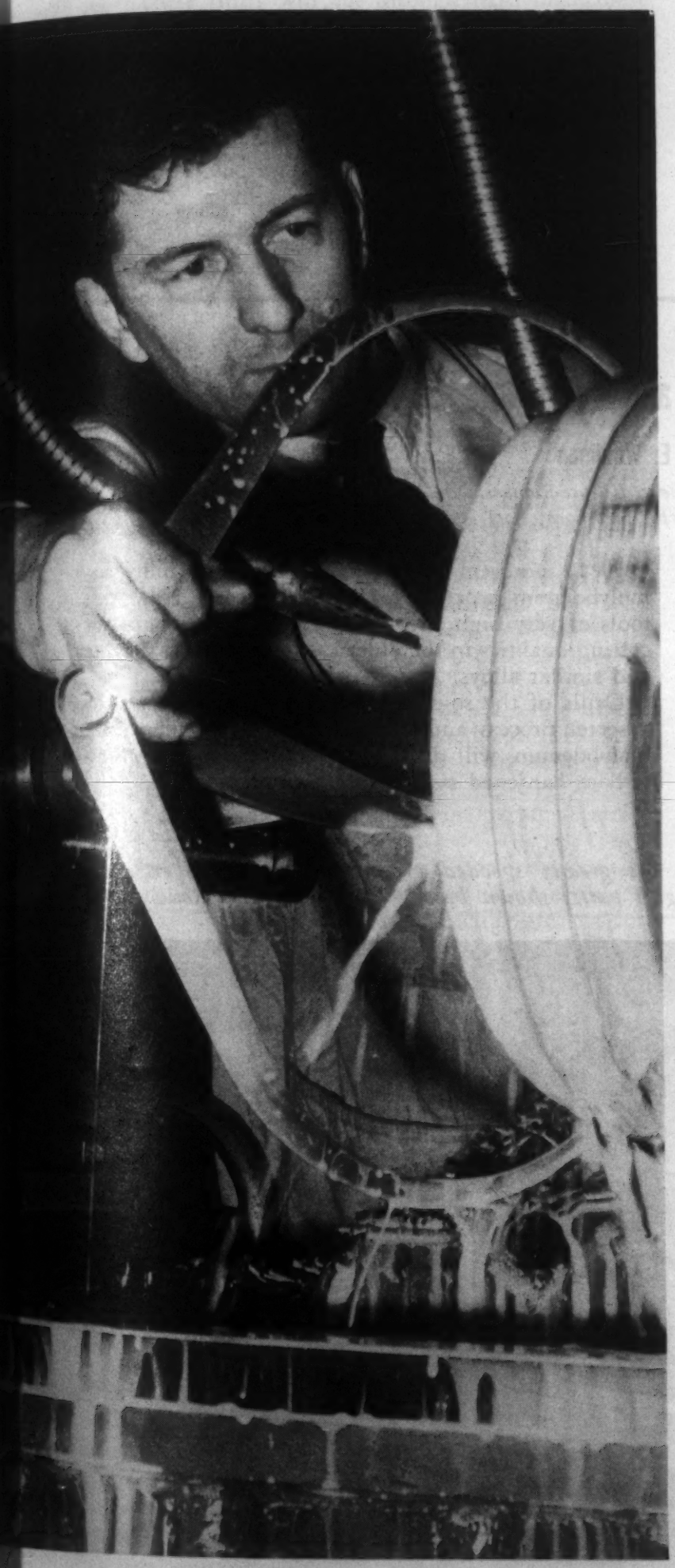
This has necessitated the installation of X-ray laboratories in most of the important die casting plants and has led to the abandonment of a large proportion of the gooseneck type of air-injection die casting machines, or their conversion to so-called "cold-chamber" machines in which positive plungers perform the injection at higher pressure.

These facts apply to machines used formerly almost entirely for aluminum alloy die castings, as the air-injection machine had already been largely abandoned for the zinc alloys. The latter are and probably will continue to be cast in plunger machines designed and well adapted for their use, as such machines can readily apply as much pressure as has been shown to be beneficial.

Cold-chamber machines commonly use pressures of 6,000 lbs. per sq. in. or higher and can handle any non-ferrous alloy suited for die casting. Their use, however, is largely for aluminum, magnesium, and brass alloys, since they are a virtual necessity for these. As they are slower than the plunger machines for zinc alloys and yield no recognized advantage in die casting the zinc alloys, there appears to be no reason for their substitution for that type of alloy.

Because of the economies of the die casting process and the pressing requirements of the aircraft industry for light castings, the aluminum and magnesium alloys have gained the widest use they ever enjoyed. Because of this and the need for high-purity zinc in other war work, especially in the manufacture of deep-drawing brass, the extent of the use of zinc alloys in die castings declined rapidly shortly after Pearl Harbor. During this year, however, the easing of the zinc situation and the disposition of Army and Navy Ordnance, in particular, to permit the use of the zinc alloy die casting for more items (such, for example, as certain types of fuse plugs) has led to wider application of these alloys and more efficient use of existing die casting capacity.

Although the application of higher pressures in die casting the aluminum, magnesium and brass alloys seems to have contributed greatly toward the production of sound castings, it is now coming to be recognized as only one factor needing control to that end. Moreover, there are grave doubts whether the use of exceedingly high pressures (even in excess of 25,000 lbs. per sq. in., in some instances) is warranted or even beneficial. Another factor, perhaps of equal importance, is control of the rate of injection. This can be effected, not only by the pressure applied to the ram, but by changing the size of sprue and gates, the rate at which the ram is advanced and the temperature at which the molten or semi-molten metal is fed.



Better methods, machines, cutting tools and cutting fluids share the credit for the year's engineering progress in the machining field. (Courtesy: Harris & Ewing)

Machining Methods and Practice

by P. W. Brown

Dir. of Manufacture,
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Perhaps the most significant development in machining practice during the war years has been the application of constantly increasing numbers of special, single-purpose, automatic machine tools. Under the pressure of war-time demands for unprecedented quantities of machine tool products, and further hampered by their inability to obtain or hold skilled machinists, manufacturers have been forced to discard older methods in favor of those which would make possible vastly increased output with a minimum expenditure of labor.

Despite the fact that such special equipment is usually high in first cost, careful studies of machine loads will, in most cases, show that this cost is actually lower than that of the large number of standard machines which would otherwise be required. Furthermore, these special machines are being rendered practically foolproof by the application of automatic timers, cycle switches, and interlocking hydraulic and electric controls. They can thus be operated by unskilled labor since, to an ever increasing extent, the essential skill is being built into the machine itself. This is particularly important where large numbers of women with no particular mechanical aptitude must be employed at tasks which formerly demanded considerable skill and training.

The employment of women has also necessitated the introduction of large numbers of small lifting devices for handling parts weighing less than 100 lbs., and which would normally be "man handled." Higher work platforms, and in some cases the use of extension handles, or a regrouping of controls, have also resulted from this same cause.

The multi-spindle, single operation machine has steadily yielded place to the multi-spindle, multiple operation machine which combines in a single integrated unit such widely differing functions as drilling, reaming, tapping, countersinking, spotfacing, back spotfacing, counterboring, and milling. Such equipment has developed, naturally, into units of very considerable size, but this is generally beneficial since it makes possible more massive construction with a resultant reduction in vibration and chatter.

Recent developments in cemented carbides have made possible the use of exceptionally high cutting speeds, particularly in milling operations, and there has been a noticeable swing towards the use of hi-cycle spindle driving motors. By converting conventional 60 cycle A.C. current to 120 cycle, the noticeable slowing down of the spindle when load is applied is almost entirely avoided.

Considerable emphasis is being placed on tool standardization, especially for single point lathe tools. Careful design of these items by the tool design department, coupled with precision grinding, makes possible a smaller inventory of tool bits, reduces the scrap normally caused by improperly ground tools,

and effects important savings in production time commonly lost when operators hand grind their own tools. The fine surface finishes obtainable on aluminum and magnesium by this high speed machining have, in many cases, brought about the elimination of final grinding or lapping operations.

Increasing attention is being paid to work flow engineering, involving the use of conveyors of all types. These eliminate the stooping and lifting necessary when work must be stacked on the floor and increase the amount of floor space available for manufacturing purposes. Line production methods have been applied with remarkable success to a wide variety of articles formerly "custom-built," articles ranging from aircraft engines to tanks and howitzers, while progressive assembly lines for both major and sub-assemblies have contributed materially to today's objective of producing more goods per man, per machine, per hour than was ever possible before.

Cutting Tools and Lubricants

by Norman E. Woldman

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There have been many outstanding engineering developments in the field of cutting tools and lubrication during the past year. These developments were stimulated by the war effort to increase production of war materials and to conserve on critical metals.

New cutting tool steels have been introduced to improve machinability and increase tool life. Boron has been added to high speed tool steels. Cobalt from 4 to 12 per cent has been added to the tungsten-molybdenum type of high speed steel. New cast tools of very high alloy content have shown superior cutting qualities to the older cast tools such as Stellite and similar alloys.

Drills of the so-called "Hardsteel" type, made by a secret process and high in cobalt, chromium and molybdenum, will drill, ream, countersink and counterbore hardened steel of any type, temper or analy-

Mechanized flame-cutting, using new types of nozzles, has greatly speeded production in such operations as the cutting of thick alloy steel blocks for field gun parts, shown here. (Courtesy: Air Reduction)

sis. These drills will cut through hard manganese steel, chilled cast iron, case-hardened steels and hardened bearing steels, leaving the holes just as smooth as a burnished surface. They function on the basis of the heat generated during drilling, annealing the metal ahead of the cutting edges.

There has been a greater use of nitrided high speed steel cutters to increase tool life 200 to 300 per cent. The treatment of high speed steel tools in salt baths containing cyanides at temperatures of about 1000 to 1050 deg. F. gives a thin nitrided case of about 0.001 in. depth, which is extremely hard and has a low coefficient of friction. Such tools as milling cutters, hobbing cutters and taps, which are ground on one face only, may require only one nitriding treatment for the life of the tool. Other tools may require renitriding after each grind.

Greater tool life can now be obtained by the improved chromium plating process. By chrome plating high speed steel tools and subsequently relieving hydrogen embrittlement through the use of a special oil treatment at 350 deg. F., greater life and higher production rates can be achieved with such tools as drills, reamers, taps, form tools and lathe tools. Taps and end mills were hard chromium plated with resulting tool life increase up to 700 per cent over the unplated tools.

The recognition of the value of ultra-fine finishes of tool cutting edges has increased tool life up to 2000 per cent. Honing or lapping the cutting edge decreases the tendency for the built-up edge to form on a tool and produces a smoother machined surface and longer tool life.

Step-type chip breakers which break the turnings into discontinuous chips have been more readily accepted. The shear angle of the chip breaker curls back the chip away from the tool point and against the shank of the tool, causing it to break. This has resulted in a marked decrease in tool wear.

Another new development was "Hyper-Milling." Inserted milling cutter blades of carbide or Stellite type material are ground with a negative rake angle resulting in improved finish and permitting higher milling speeds on high strength alloy steels. The use of very high peripheral speeds for milling aluminum alloys is also receiving a great deal of attention today.

Attention has recently been drawn to high speed band saw cutting wherein friction cutting is obtained by accelerating the speed of the conventional band saw up to 12,000 ft. per min. At this speed the saw generates sufficient heat through the sliding action of the teeth to melt the metal being severed.

Salvaging of small pieces of scrap high speed tool steels and other tool bits by brazing inserts in carbon or low alloy steel shanks is being adopted extensively. Two methods are being used: (1) brazing after the material is hardened, and (2) brazing and hardening in one operation.

Several new cutting oils and coolants were introduced during the year. The general trend in the evolution of new lubricants and the application of old standbys is diversification of the list and the use of special oils for specific problems (although a creditable tendency toward standardization on the basis of suitability tests has developed). Soluble oil emulsions and sulphurized mineral oils have expanded their applications.

Temperature control of coolants is increasing in use as are cleaning devices that remove work-particles from circulating and re-use cutting oil systems. Both practices improve finish and performance. By and large cutting oil selection and use is being placed on an engineering basis with notable improvement in output and in tool life.

Arc Welding

by James W. Owens

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Owing to the sudden tremendous utilization of arc welding in the fabrication of ships hulls, in machinery and in the weapons of war, the year 1943 has been notable for a rude awakening of engineers, management and regulatory bodies to the fact that the *consistently* successful application of the process, as a production tool, is dependent on a wide knowledge of and strict adherence to a number of underlying design and fabricating principles involving chemistry, metallurgy and thermo-physics. Also, that all of these principles are closely related in the practical application of the process and that it is just as essential to know what cannot or should not be done as to know what can or should be done.

General progress has been made in the use *(where specifically applicable)* of a.c. rather than d.c. equipment, and of a "deep fusion process" (often called "deep fillet welding") instead of surface fusion process. In one case a large shipyard on the Pacific Coast is using the deep fusion process extensively for the continuous welding of lap and closed tee joints wherein the welds can be made in the horizontal and flat positions.

One company has recently concluded an extensive investigation on the fabrication of arc welded crankshafts and is about to place such shafts on a production basis. The writer has not seen these shafts; however, in view of his research on this problem,

and the company involved, he has every assurance that their routine production will be one of the outstanding developments of 1943.

Two companies have superimposed a high frequency current on their transformers to facilitate the starting of the arc. In one case, the transformer is intended for the manual welding of light sheet metal used in aircraft fabrication and the other for the automatic welding of all thicknesses of metal. The application of a superimposed high frequency current is not new; what is new is the use of a frequency outside of the radio transmitting band so as to avoid interference.

Armor plate is being extensively welded in routine production. Here again, the application is not new as the Navy has for years welded blisters to the armor plate of ships. A successful technique has been developed, however, for the welding of the armor on tanks by the careful selection of the armor used and the use of low alloy or austenitic electrodes.

Aircraft parts fabricated from magnesium alloys are being manually and automatically welded with a tungsten electrode arc under a shield of helium gas. Both direct current with reversed polarity and rectified alternating current have been found preferable to unrectified alternating current. The importance of this development to the aircraft industry has been summarized in the statement that if the rivets on the Douglas DC-3 transport plane were eliminated by its use, the reduction in the cost of flying during the normal life of this plane, due to reduction in horsepower, would be equivalent to twice the original cost of the plane.

Atomic hydrogen arc welding continued to expand in application, especially for the welding of high alloy and tool steels and for other special work where its intense, nicely-localized, fluxless arc is most applicable.

Among the numerous Welding Research Committee's undertakings which have produced results in 1943 and on which information is available are those dealing with the predictable ductility in the fusion zone of high carbon and alloy steels.

In conclusion it can be definitely stated that not only has marked progress been made during the past year in the development and utilization of the arc welding process but if a contrast be drawn between its development in World Wars Nos. 1 and 2, it is astounding. This is due not only to the inherent adaptability of the process but to the fact that the process is now in the hands of engineers, scientists and executives who are devoting their professional and business lives to its fullest development.

Low-Temperature Joining

by Kenneth Rose
METALS AND ALLOYS

In the field of low temperature joining of metals, the past year has seen a considerable expansion in volume, and the introduction of several new materials to commercial use.

The soft solders—for which lead-tin alloys have been standard for many years—have continued the trend begun when the Japs seized most of the world's tin supply. Government regulations fixed 30 per cent, then 21 per cent tin as the maximum to be used in solders without priority, and this content was reduced to 5 per cent effective Jan. 1, 1944. The series of wartime S.T. solders (*S*ave *T*in), using 1¼, 2½, and 5 per cent Ag with lead, were developed to the point that they will meet about 90 per cent of civilian requirements. Uses of the soft solders, principally in the tin-can, radio, and sheet metal fabrication fields, now require more than double the pre-war production.

The 1943 picture for silver brazing has been one of accelerating conversion to war work and of expansion of applications in both ferrous and nonferrous fields. No new materials have been developed, but output of standard alloys has increased to five or six times peacetime levels. A feature of the past year has been the increasing application of silver brazing to mass production techniques, with the joining metal frequently preplaced as strip or wire, and the heating done in automatic or semiautomatic equipment. Furnaces, receiving stacks of parts and fusing the alloy at a fixed temperature, and induction heating equipment have been especially useful for high production.

Aircraft, automotive, refrigeration and marine industries are taking the bulk of the production now. The brazing fraternity are particularly pleased with the wide expansion of the training programs for silver brazers during the past year, and with the outlook in the automotive industries, where large sums have been set aside by the leading corporations to study new uses for the method.

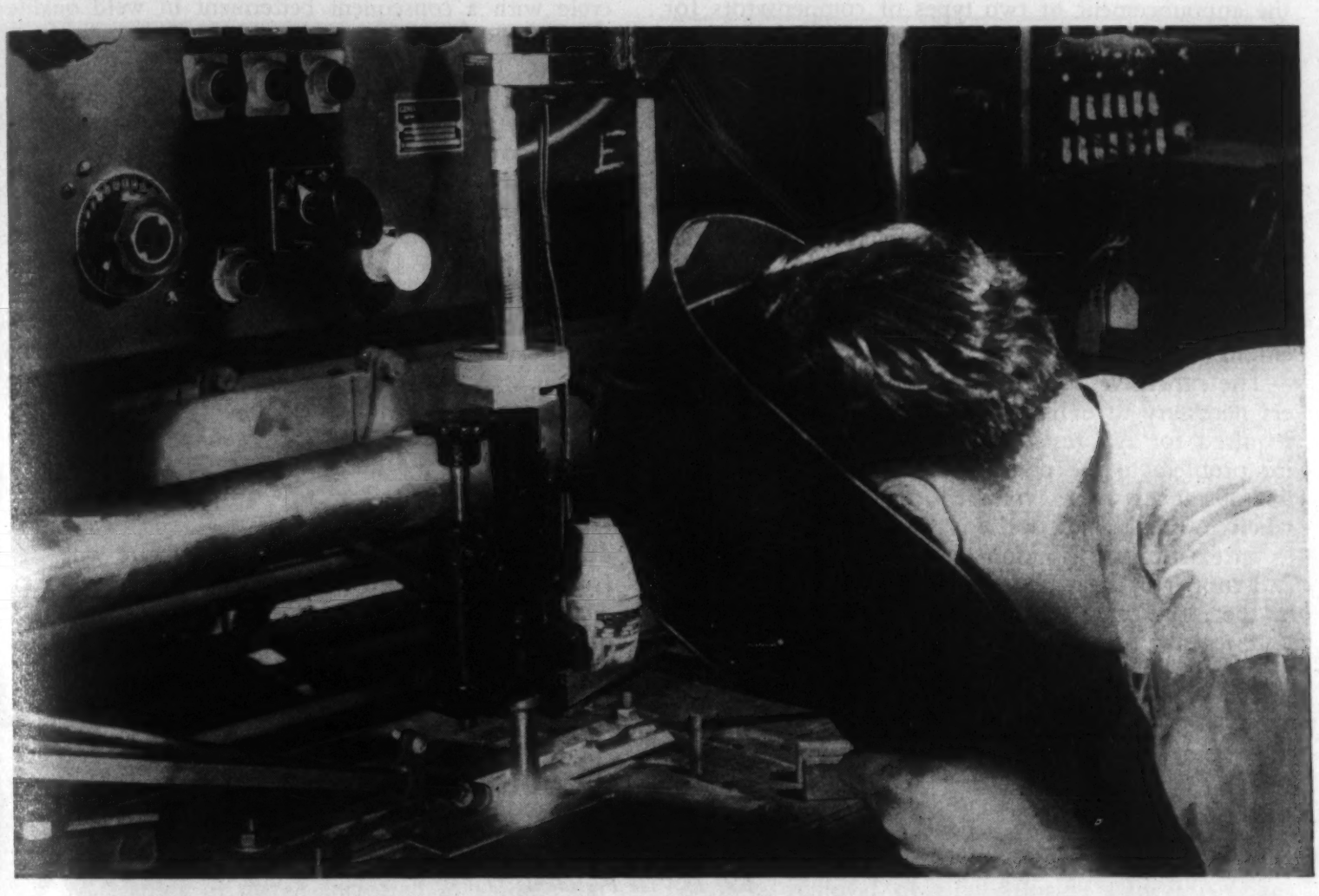
A special group of indium-bearing silver solders has been produced during the past year for certain vital war uses. Indium to the extent of 2 per cent has been found to increase wettability and spreadability, and especially to increase metal-to-glass bonding properties. Its applications have been largely in the aircraft industries.

Joining by the low-fusing, high-strength alloys, known as eutectic welding, continued to expand its applications in the fields of repairing and fabrication. These alloys offer special advantages in tool repair, where it may be important that the repaired pieces have high strength and that the temper of the tool be preserved.

Several new joining processes, grouped loosely as adhesive bonding, have been given public notice for the first time during the past year. They are essentially the fusing and forming of a synthetic plas-

tic between the parts to be joined. The most widely publicized of these were the Reanite and Cyclewelding processes. Providing a means for making metal-to-metal joints at low heats and pressures, this process is at present restricted to war work, and almost entirely to the aircraft industry. The bonds are said to show a strength equal to welded fabrication. Probably its greatest possibilities lie in the bonding of wood, rubber, etc., to a metal or nonmetal, where it does not compete with the present highly efficient and economical mechanical welding processes.

These joining processes offer possibilities in refrigeration equipment, where the insulation may be joined directly to the metal sheathing; in aircraft construction, where the nonmetallic bond lowers vibration; and in all fields where a strong metal-to-nonmetal bond is desired.



Automatic helium-shielded arc welding of magnesium alloys, using tungsten electrodes, promises to boost the application of these light metals. (Courtesy: General Electric Co.)

Resistance Welding

by J. R. Fetcher

Edward G. Budd Mfg. Co., Philadelphia

The year 1943 witnessed many new achievements in the field of resistance welding. Most of these developments were brought out in technical papers presented at the annual meeting of the American Welding Society in October. From the nature of these papers and the interest shown in them, it is apparent that resistance welding has now become one of the basic tools of industry. We are now able to spot weld many of the air-hardening steels, such as S.A.E. 1035, 1045, 4130 and many types of armor plate — due largely to the work done at the resistance welding research laboratory at Rensselaer Polytechnic Institute on post-heat treatment of welds. An initial impulse of energy fuses the metals together and a second impulse shortly after the first, at slightly reduced current, reheats the weld, thereby annealing it. This second heating is, in effect, a tempering operation which changes the brittle martensitic structure of the weld to a tough and ductile zone of good mechanical properties.

The constant demand to spot weld heavier thicknesses of steel has resulted in the perfection of the welding process called pulsation welding. By injecting the heat into the weld in several impulses, it is possible to use less current than that for single impulse welding and electrode tip wear is reduced. Spot welding of two thicknesses of ½-in. plate is possible, and that of two and three thicknesses of

¼-in. steel is in current production.

The design and fabrication during 1943 of cargo carrying airships, entirely spot and seam welded, is another mile post in the expanding use of resistance welding. Because of the advance in quality control, it has been possible to spot weld highly stressed structures of this type where every weld must be of guaranteed strength.

A big step forward in AC welding control was the announcement of two types of compensators for minimizing variations in the energy delivered to the weld. One of these is a current regulating device which maintains the current to a preset value regardless of changes in secondary impedance, power factor, and voltage. The other type, somewhat simpler in construction, compensates for variations in voltage only. Because the heat delivered to the weld is a direct function of the current squared, small variations in current cause large variations in this heat. Therefore, the importance of current regulating apparatus such as these compensators cannot be overemphasized.

The expensive transformers, sub-stations, and feeders necessary to deliver the large single phase loads required for AC resistance welding constitute a major problem to the power companies and users. In one instance, where voltage drop became excessive when a number of welding machines were added to an existing distribution system, the cost in dollars and copper of increased feeder capacity was obviated by the installation of compensators.

A recent promising development is the conversion electronically of single phase welding loads to three-phase. This results in a balanced three-phase load of smaller magnitude per phase, and the shock to the system is consequently reduced. This may have important applications on heavy gage welding requiring large doses of power.

More accurate control of electrode force has been achieved with the development of special valves and "inertia-less" machines. This has permitted controlled changes in tip force during the welding cycle with a consequent betterment in weld quality particularly in heavy gage welding.

There have been a great number of improvements in both the electromagnetic and the condenser discharge type of welding. Applications of this equipment have increased particularly in welding aluminum alloys and where a large source of AC power is not available.

Most significant in many ways is the amount of basic research work inaugurated last year. There has developed a consciousness of the importance of the electrical, thermodynamic, metallurgical and mechanical relationships existing in the field of resistance welding. As in the case of fusion welding the study of residual stresses and their influence on the fatigue and impact strength of spot welded structures has lagged behind the initial development. Now, however, there is an effort to learn more about these factors both experimentally and by theoretical predetermination. It is hoped that this work will bear fruit so that we shall obtain a better quantitative picture of these relationships and further expansion of the use of resistance welding can be justified with assurance and safety.

Gas Welding and Cutting

by W. G. Theisinger

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Recent developments in gas cutting and welding have been largely ones of refinement of technique and their application to improved methods rather than startling changes of equipment and materials.

A highly welcome saving in manhours has been the main purpose of new gas cutting methods while meeting the demands for increased production during these times. Multiple torch cutting, in which as many as 14 torches operate simultaneously from one templet, is an example of one of the unusual applications of the gas cutting process. The time ordinarily required for setting-up, handling, and cutting single plates has been reduced by means of stack cutting of anywhere from 10 to 20 or more plates at one time. In place of the frequently haphazard arrangement of cutting parts from full sized plates, nesting has been employed to obtain the maximum number of gas cut pieces from a given area of plate. This results in a substantial reduction in scrap and the number of cuts that are made.

The industries that melt metals such as the foundry and the steel mill have adopted machine gas cutting as a means of eliminating or materially reducing certain costly operations; in the case of the foundry for smooth, flush riser cutting which minimizes or eliminates expensive grinding, and in the instance of the steel mill for cutting slabs and cropping or cutting ingots frequently over 50 in. in thickness. The shipbuilding industry employs the oxyacetylene process for the important time-saving operation of production line shape and parallel cutting, as well as flame straightening to remove the buckles encountered in bulkheads, floors and deck plates, which have become warped during welding and assembling.

The divergent nozzle has been one of the spectacular developments of equipment, as it maintains a narrow kerf with a straight cut through the thickness of the section. Increased cutting speeds, precision, and the maintenance of higher oxygen concentration to a greater depth of the cut are possible with this new cutting tip. The increased value of flame machining for scarfing and edge shaping operations is becoming a time saving procedure of great

importance because of the flexibility of this process and its equipment. Flame priming or cleaning and dehydrating with the oxyacetylene torch offers a superior plate surface preparation for painting, by quickly removing semi-tenacious scale and other foreign substances which had been removed formerly by the more costly chemical and mechanical cleaning methods.

The rebuilding and reclaiming of worn parts in railroad and other industrial equipment have been carried on extensively by the use of oxyacetylene processes, newly developed welding bronzes having contributed greatly in this field. New equipment and replacement parts are regularly fabricated by means of the combined welding and cutting methods. The aeronautical industry has increasingly employed oxyacetylene procedures for the rapid and accurate welding of precision parts and tubular structures.

Cleaning cartridge cases in soap solution. (Courtesy: Corcoran-Brown Lamp Div., Auto-Lite Co.)

Cleaning and Pickling

by Walter R. Meyer

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Blast cleaning of metals increased in volume during the year for several reasons. One is that rust and scale can be removed without danger of hydrogen embrittlement which may result from pickling. Another is that alloy steels containing, for example, molybdenum are difficult to clean and pickle without leaving a smut which may interfere with subsequent finishing such as plating, blackening, or organic finishing. The use of blast cleaning results in a clean surface for finishing. Blast cleaning is also being used more extensively for cleaning large objects *in situ* such as tanks, large castings, etc.

Chlorinated solvents are still tight and because of this there has been a much wider use of emulsion cleaning. The work to be cleaned is immersed or sprayed with solvents containing emulsifying agents so that a water rinse or spray will remove oil plus solvent. Solvents dispersed in water are also being employed for cleaning metals, usually in spray washers. In such cases there is much less tendency to rust afterwards than if alkaline cleaning were used. Emulsifiable solvent cleaning has a distinct advantage in that it removes solid dirt as well as organic dirt. This means that electrodeposits are more adherent, brighter and less porous than is the case if solid smut were left on the metal surface.

One drawback to the wider use of emulsion cleaning is that solvent or solvent-vapor degreasers are usually not designed for simple conversion to emulsion cleaning. However, with proper designs of equipment available, there will be much more extensive use of emulsion cleaning.

There have been some distinct improvements in alkaline metal cleaners during the year. Some of these have been based on the use of new detergents or surface active materials that have better detergency than rosin soaps and which do not have the disadvantages of poor rinsability and reaction with acids to form insoluble organic acids.

Most new "wetting agents" have proved to be poor as detergents and there was much misuse because of improper understanding of true detergency. Certain wetting agents that form thin foams have made possible better alkaline cleaners for high current density anodic cleaning of steel. These cleaners are effective for removal of both organic and inorganic dirt.

It is being realized generally that anodic cleaning of steel is much more advantageous than either cathodic or anodic-cathodic cleaning. Most highly effective alkaline cleaners for steel work better when the work is made the anode.

Special attention has been given to cleaners for preparing aluminum for resistance welding, and for complete removal of zinc chloride soldering fluxes. It has been found that aluminum is best prepared for welding by first degreasing without etching and then removing the oxide in dilute sulphuric acid. Cleaning is effectively done by first using emulsion cleaning and then an alkaline cleaner inhibited with special silicates.

Phosphoric acid cleaners have been used somewhat more widely for preparing steel for organic finishing and there is evidence that cleaning of food containers such as milk bottles and cans can be done very effectively with acid detergent solutions in place of alkalies. The advantages of wetting agents in acid pickles have been widely publicized and their use has become much more extensive.

The many advantages of electrolytic pickling with co-deposition of tin have resulted in a very wide adoption of this method of descaling of many types of war goods. For example, steel airplane propellers are being pickled in this manner because pickling must be done with a minimum attack upon the base steel and in a very short time. The tin consumption is very small because it is stripped off the steel after pickling and is recovered.

Plating and Finishing

by E. W. Cochran

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The speedup in war production during 1943 made it increasingly important to conserve critical materials. Electroplating and other modern finishing methods offered conservation opportunities galore, through their provision of *surface* nobility in place of critical alloy all-the-way-through, through the increased corrosion resistance and longer life they conferred on many vital war instruments, and through their occasional reclamation functions.

Chromium plating, once the "glamour finish" of the consumer-product field, found widening use for the salvaging of worn or mismachined parts and for prolonging the life of cutting tools, dies and gages. Precision and economy in such operations were vastly improved by the development of better racking, "thieving" and masking methods during plating. The application of porous chromium plating to improve the life of cylinder bores or piston rings in aircraft motors, diesel engines, etc. made notable strides.

Iron plating has also been successfully applied as a non-critical method of salvaging worn tools and equipment where the superlatively high hardness of chromium is not required. Side by side with plating-for-reclamation has been a steady increase in the use of metallizing for building up worn or mismachined parts.

The use of electrodeposited lead for protective coatings has steadily increased. Military requirements and the need for replacing critical materials accelerated this trend. Another soft metal — indium — became one of the truly vital tools of war through the successful adoption of indium-plated hollow steel propeller blades with a good corrosion- and fatigue-resistance.

Additional electrotinning lines were installed by the steel industry, which is now able to electrotinplate something like 2 sq. miles of steel per day. One of the war's major conservation achievements by virtue of the heavier hot-dipped tin coatings it replaces, electrotinplate is today the center of lively speculation as to its future in a "normal" economy. Most experts are agreed (1) that the electrolytic process *is* here to stay and (2) that, however, hot-dipped plate is far from out of the picture.

Cadmium plating staged a comeback for many parts used in the war program when the supply situation vis-a-vis zinc changed somewhat and when Army and Navy aircraft specifications restricting its use were relaxed on discovery that under certain high-temperature conditions some zinc-plated steel parts became seriously embrittled.

Zinc-plating of steel, on the other hand, was expanded tremendously with the growing demand for substitutes for brass, stainless steel, etc. possessing adequate corrosion resistance. A series of special baths (Anozinc) was developed to improve protection and to permit a variety of finish-colors. The service life of zinc coatings has been improved by wider application of the Cronak process, which produces a chromate film that inhibits the corrosion of zinc in outdoor or moist environments. Highly useful blackening processes have also been developed specially for zinc surfaces.

Blackening of metal parts in general continued to grow in use and several new baths were developed. The predominant corrosion-resisting and oil adsorptive coatings for steel produced by chemical treatment continue to be such phosphating treatments as Parkerizing and Bonderizing, which successfully entered certain war-product fields new to them.

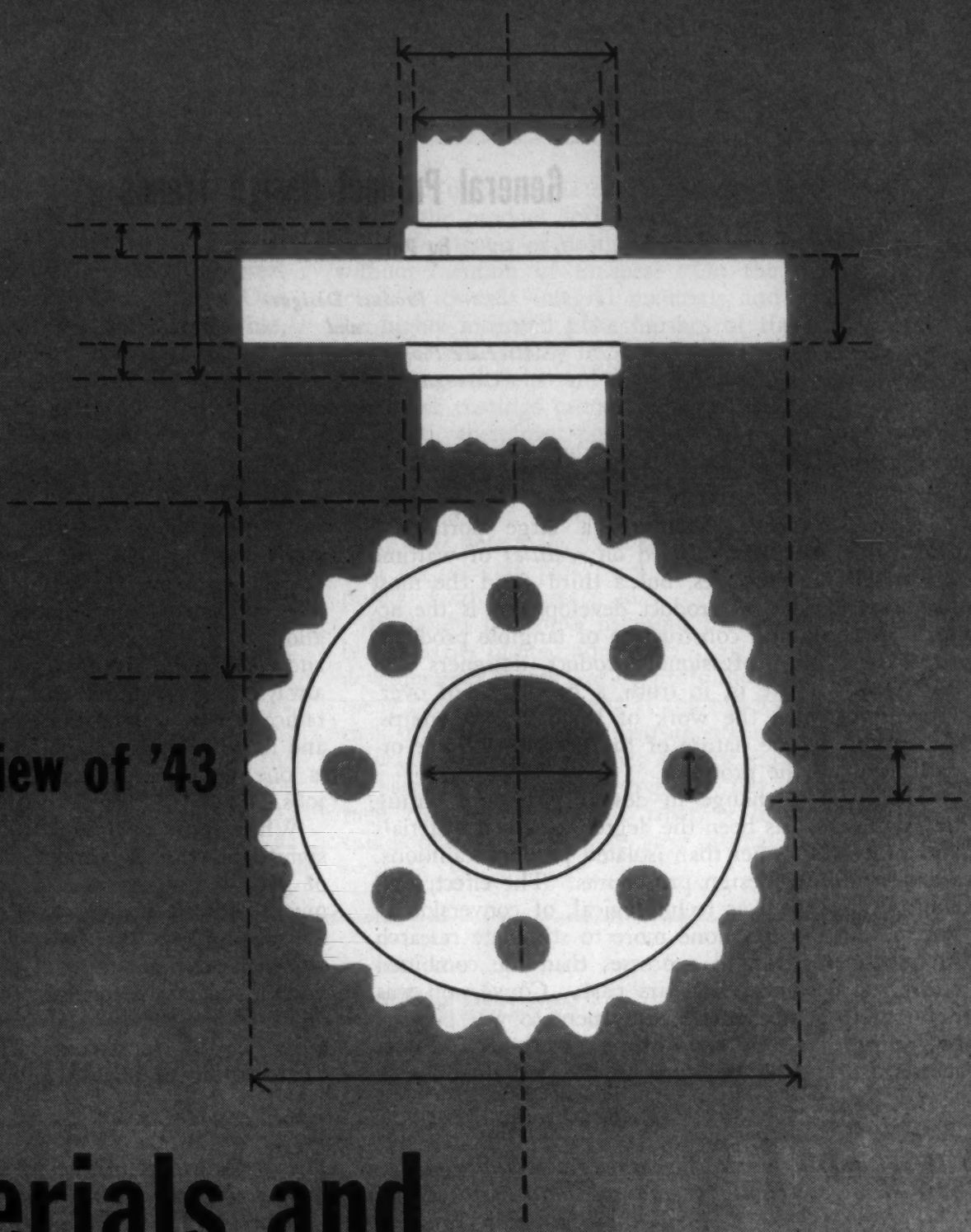
New installations for anodizing aluminum alloys were made in considerable number. Many of them were small and featured power-supply via flexible rectifier sets. Rectifiers — primarily the selenium and copper/copper oxide types — continue to take over certain plating jobs formerly done by motor generator sets where the rectifiers are demonstrably more efficient or convenient.

Also in the equipment field are the development of new deburring equipment with real advantages and the adaptation of existing buffing, rolling and brushing equipment to deburring work.

The critical problem of protecting munitions from rusting during storage and shipment overseas was met in a variety of ways, including the use of protective waxes, of highly efficient slushing oils and of a "packaging" technique involving enclosure in a Pliofilm jacket in the presence of silica gel.

There were many changes in paints to take advantage of the faster drying possible through wider use of new infra-red drying units. Paint recovery (for salvage) reached a high degree of proficiency, and one manufacturer offered a spray system featuring electrostatic charging of the work to attract paint droplets to it and reduce the overspray.

For new proprietary finishes developed during the year, readers should study the Table of New Materials and Finishes of 1943 in this issue. Beyond all this there have been many developments in processes and equipment that are still under wraps but which are certain to result in greater production or increased protection against corrosion.



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General Product Design Trends

by Peter Muller-Munk

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and
Associate Professor of Industrial Design
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Much is being written and published about post-war dreams and models. Some of this post-war "design" is sheer dreaming, a large portion is reasonable speculation based on *realities* of wartime materials and processes, but a third (and the most important) type of product development is the actual designing and construction of tangible products, supervised by professional product designers and engineers. There is, in truth, a good deal of overlapping between the work of the last two groups, depending on the nature of the product and the organization of the producer.

The greatest change in design procedure during our war years has been the degree to which materials and processes, rather than isolated product traditions, are determining design procedures. The effect, psychological as well as technological, of conversion to war production has done more to stimulate research in new materials and processes than the combined efforts of designers in years past. Conversion was not merely a mechanical adjustment to war but the beginning of a new era with new methods and new standards, and it brought us the reevaluation of products, procedures and materials which the designer had long advocated but rarely achieved.

In the field of materials it is clear that the alloy steels and the light metals are playing a very much larger and more important role than ever before. The refinements and technical growth of magnesium alloys, of aluminum and of rustless metals poses new and challenging problems for the designer. It is not always easy to think and to design in terms of radically new weight-strength relationships. Further and more definite research in the nature of materials is one of the designer's most important wartime jobs.

While shifts in the relative position of metals are significant, the expansion of the plastics industry, of glass technology and of laminates are occupying much study in design offices. After the first period of substitutions, we have now reached the stage where the critical supply of practically all of the important materials requires that they be tested in terms of their individual merits and no longer as mere "ersatz" substances. Here again a more accurate listing of physical properties acts as a broad-

Heavy duty automotive gears are sometimes made as centrifugal castings instead of as forgings. Here are shown a gear blank forging and finished forged gear (upper right) and a 2-in-1 mold gear blank casting and a finished cast gear (lower left). (Courtesy: Ford Motor Co.)

ening influence. Ordnance requirements and the standardization of testing methods have done much to establish trustworthy guidance for design projects.

As far as product shape is concerned, no great change resembling a trend has yet occurred. One of the healthiest influences of war upon design has, in fact, been the rediscovery of shape, once the glittering peace time trim was removed. It can only be hoped that the stark simplicity and ruggedness of ordnance equipment will not again disappear in a new orgy of useless decor. Shape as a functioning element of products, and not as an arbitrary housing over mechanisms, has too well proven itself to be easily forgotten.

Shape itself can hardly be considered without mention of assembly and here the tremendous development of welding must rank as one of the most influential processes affecting product design. Welding, again closely related to weight-strength considerations, and beyond these to assembly-time factors, will continue to affect shape and surface trends even more in the future than it already has in the past. Together with more and more intricate die castings and the increase of injection molding capacity, welding and bonding of similar, as well as dissimilar materials, is of the greatest possible concern to the product designer.

No discussion of design trends will be complete without mention of finishes. On the whole, the trend is towards integral materials and away from the highly mirrored plate finishes of the past. On the other hand, many important advances in the porcelain enamel field and in the technique of plastic and other coatings cannot help but play their part. It would, therefore, perhaps be truest to say that no very visible trend exists as yet in the field of finishes, but rather that the former trend has been broken and that we are entering a new phase with many new potentials. Finish is again being considered an integral part of a product, rather than a purely dazzling surface film.

It should be borne in mind that this discussion is necessarily limited and omits many of the startling developments which are of profound significance to today's product designer. If the products and materials, the processes and instruments he now applies to war are used wisely they will benefit us and will be part of peace and of progress. But it will be the men that use them and what is in these men's minds that will determine their ultimate value.

Process Conversions and Redesigns

by T. J. Little

Chief, Conversion Eng. Section
New York Ordnance District

Under the impetus of a program initiated in the Ordnance Department by Maj. Gen. L. H. Campbell, Jr., chief of the department, the savings in critical material consumption that had been achieved through direct substitution of less critical materials in ordnance were heavily augmented in 1943 by countless conversions from wasteful or time-consuming processes to others that were more rapid or efficient. This program was carried out by Ordnance and industry working as a team and has been responsible for enormous savings in materials, in machine-time and in manpower consumed in the manufacture of Ordnance equipment.

The program was so vast, its results so impressive and the number of people involved so great that this article cannot possibly distribute the credit properly or, in fact, do more than describe briefly a few typical outstanding examples of redesigns in each of which was involved a change from one process to another that saved materials, machines or manpower.

In a large number of cases substantial savings were obtained by substituting steel stampings for components made from machined bar stock or steel forgings. The cold working of metal in stamping permitted the attainment of physical properties that passed the most rigid tests. [The "conversion to stampings" program has been described in an article in METALS AND ALLOYS for October, 1943—Editors.]

Mass-production *welded* 60- and 81-mm. mortar shell have been designed in place of the models made by machining steel forgings. In the new method a steel section is rolled, blanked out and drawn to make one half of the shell, and is then welded to an identical piece to complete the shell contour. It is estimated that this redesign will save 6,000 tons of steel and 750,000 machine hours on the present procurement.

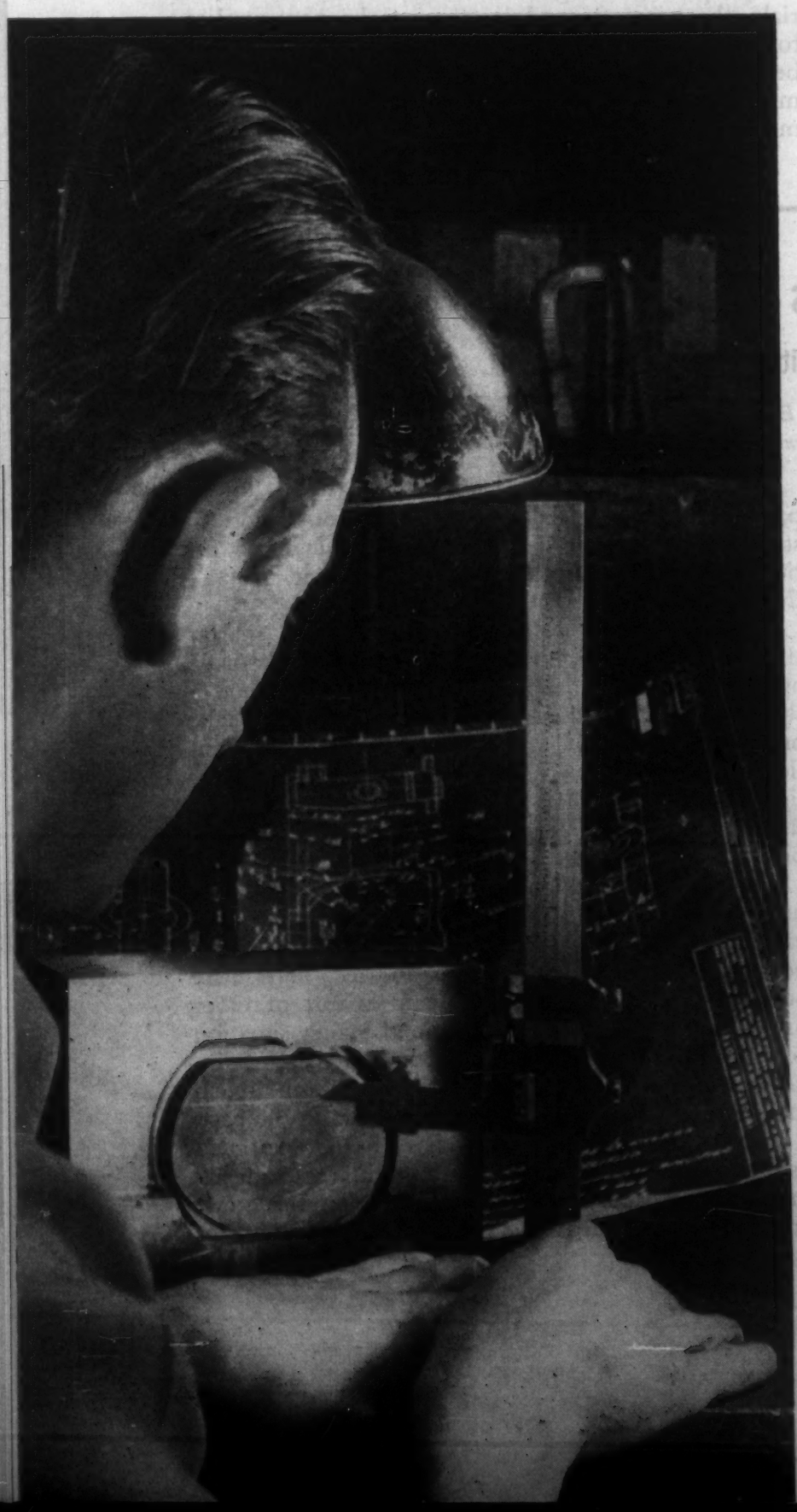
The rapid production, design complexity and virtual elimination of machining permitted by die casting non-ferrous alloys has brought this process into new prominence for making tank and jeep parts, fuze bodies, uniform button shanks and a host of other products. A favorable change in the zinc situation and the proof of quality obtained by systematic radiographic inspection has made pressure die casting much more attractive to ordnance engineers than in the past.

A long list of war products have been redesigned as press-forgings. The most spectacular outside of ordnance perhaps, are the forged aluminum aircraft engine cylinder heads that were once made only as

castings. A typical ordnance conversion in this direction is the manufacture of armor piercing shot by hot pressing a sheared billet into rough shape before machining, in place of machining the shot out of solid bar stock. This redesign saves 50 per cent of the steel used in making the shot by the former method.

The public read for the first time in 1943 of one important process conversion that had been underway for several years—the manufacture of gun tubes by hot-piercing instead of centrifugally casting or of boring out a hammer forging. The greatest saving in this conversion is production time, although the material saved is also important.

Many centrifugally-cast ordnance parts formerly made by other methods are the result of recent redesigns. Considerable application developed, especially in the New York area, for a combination of centrifuging and investment casting (the "lost wax" process) for making precision castings.



The increased use of die castings in recent years has been accompanied by better design of such parts. A unit die casting die is here being laid-out prior to machining the cavity. (Courtesy: New Jersey Zinc Co.)

Powder metallurgy had its biggest year, and many ordnance parts were redesigned, to the general benefit of the conservation program. Indications are that 1943 ordnance production will include some 5,500 tons of ferrous and non-ferrous metal-powder parts.

Among the other current trends that cannot be ignored are the tendency to specify iron castings wherever they can perform satisfactorily and the frequent use of malleable iron in place of bronze castings or steel forgings.

Suggestions for substitutions or specification changes received by the Ordnance Dept. have totaled over 3300, of which more than 50 per cent have already been adopted. This high percentage is a tribute to the ingenuity and fine cooperative spirit of the metal-industries engineers who have worked with Army Ordnance personnel on this conservation program.

Getting the Most from Available Materials

by Howard Coonley

Director, Conservation Div.
War Production Board, Washington

The outstanding feature of our industrial war effort has been the speed with which we have turned out tremendous quantities of munitions. Germany and Japan knew we had great productive capacity but they had no conception that we could produce so much in such a short time and of so high a quality. In fact we did not know it ourselves.

Research developments in metallurgy, chemistry and engineering design have played a vital part in this successful race to overhaul and outstrip the axis. In 3 yrs. we have overcome 15 yrs. of preparation by our enemies.

Countless examples could be given of accomplishments that have speeded up production in the fields of substitution, down-grading, simplification, standardization and revision of specifications. A few examples may indicate the pattern that the War Production Board has followed.

The steel cartridge case program is a particularly outstanding example of effective substitution. An extreme shortage of copper early in 1942 made it apparent that some substituted material would have to be found in order to assure the armed forces of sufficient ammunition. Steel cartridge cases had been the subject of experiments for years.

After many obstacles were overcome in the fabrication of a satisfactory steel case, conversion from copper to steel has been successfully accomplished in several different sizes. Through these substitutions a saving of more than 200,000 tons of brass have been made per year.

Thick polished plate glass has been substituted for steel chutes in coal mines for use where there is an acid atmospheric condition and where abrasion is an important factor. In two large collieries plate glass has shown a life of 15 to 1 compared with steel.

Porcelain enameled carbon steel in place of stainless steel is being used very successfully and to a large extent in aircraft exhaust systems.

A major step in the conservation of tin has been the great increase in the use of electro-tin plate with ½ to ¾ lb. of tin per "base box" as compared with a minimum of 1¼ lbs. in the case of the hot dip tin plate which it has replaced.

On account of their lightness in weight and low coefficient of expansion, plastics are particularly desirable for certain end products. Among their applications are: Bomb fuses, canteens, aircraft cockpit ventilators, helmet liners, aircraft ignition parts, flare containers, practice bayonets, bandage containers, and fuel tubing.

One of the important factors in saving scarce materials has been down-grading. A notable example is the saving that the Maritime Commission has made in bearing metals. By changing from a tin base to a lead base babbitt, a saving of 450 long tons of tin per year was made; and by substituting "composition M" bearing metal for "composition G" a saving of 1500 tons of primary copper was accomplished.

In the field of simplification an outstanding example was the schedule for incandescent lamps, which reduced the number of types from 3500 to 1700, effecting a yearly saving of 35,000 lbs. of solder, 2000 lbs. of tungsten, and 1,200,000 man-hours of labor.

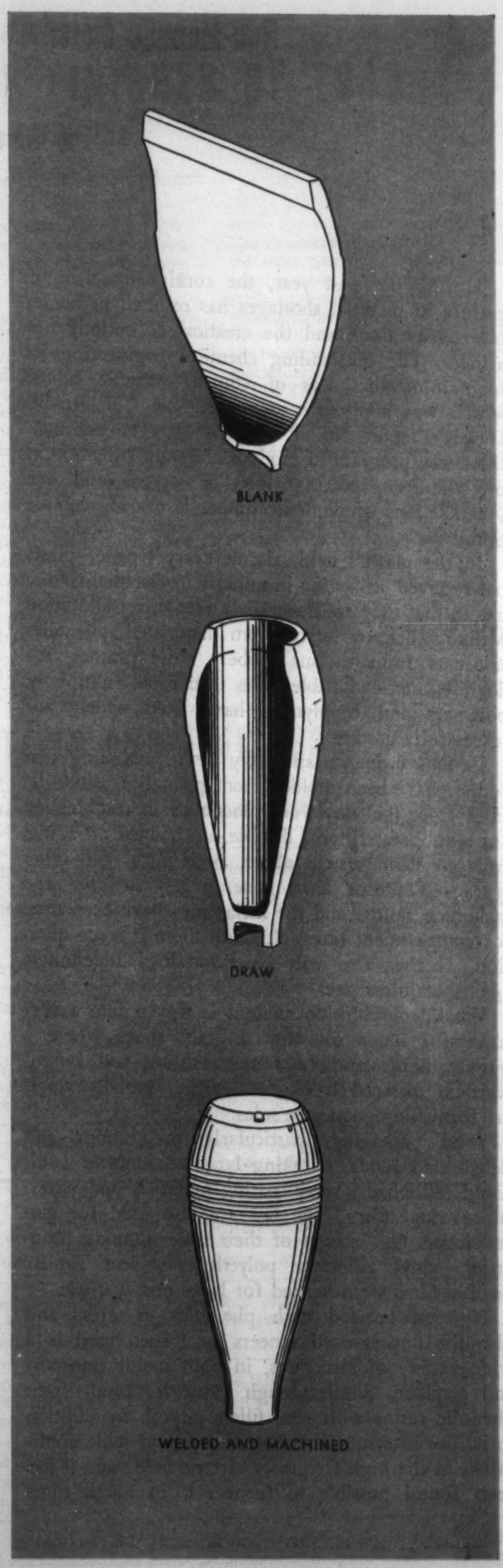
Standardization and interchangeability are of special importance in all equipment for armed forces. A notable case is that of air-cooled internal combustion engines. Repair parts were reduced 40 per cent, and basic models by 50 per cent. As approximately 650,000 of these engines will be produced in 1943, the savings in inventories alone will be very substantial.

Alternate specifications have been a major activity of the War Production Board for almost 2 yrs. Developed in cooperation with the Army, Navy and other Government Departments with the support of industry's outstanding engineers, Alternate Specifications made it possible to conserve thousands of tons of critical materials without weakening the effectiveness of the end product—whether it be the steel used in a ship or the ribbon used in the office worker's typewriter.

To date 575 Emergency Alternate Federal Specifications and Amendments have been completed by 71 Federal Specification Committees.

In developing its program of conservation of critical materials, facilities and manpower, the Conservation Division of the War Production Board has had one all-important purpose; to help win the war in the shortest possible time. While materials and manpower are essential and invaluable, time is the most important of all factors, and substitution, down-grading, simplification, standardization and specifications, all save time.

Many of the accomplishments achieved by these unique techniques are of permanent value and will be of inestimable help in our post-war problems of relief and rehabilitation of the war-torn countries.



Process steps in the manufacture of the Murray welded shell. (Courtesy: Army Ordnance Dept.)

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NOMINAL COMPOSITION	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
NON-FERROUS ALLOYS	Cerrotru	Bismuth base alloy	Low melting point, good strength, virtually no net shrinkage after casting and aging.	For most exact duplication of surface detail or dimension in mold work, layout, die mounting, grouting, etc.	Cerro de Pasco Copper Corp.
	Chace 772	Over 70 Mn	Resistivity 1050 ohms per cmf., high thermal expansion, good damping and tensile properties.	Low-temperature resistors, thermostatic devices, instruments, etc.	W. M. Chace Co.
	Elkonium 23, 25 and 117	Ag-base	No. 23 has low contact resistance; No. 25 is non-welding on inrush currents; No. 117 resists transfer and sticking.	Electrical contacts.	P. R. Mallory & Co., Inc.
	Nada NT-2	87 Cu, 4.75 Sn, 0.75 Pb, 3.25 Ni, 4.25 Zn	Low-tin bronzes with properties equal to high-tin bronzes like 88-8-4 (Govt. "G" Bronze).	High-strength, corrosion-resistant sand castings.	Nassau Smelting and Refining Co.
	Nada NT-3	87 Cu, 4.75 Sn, 0.75 Pb, 2.25 Ni. 5.25 Zn			
	NBM Silver Babbitt	Pb-base, contains Ag	Similar to tin babbitts: retains hardness at high temperatures, bonds well, resists squeezing-out and corrosion.	Replacement for tin babbitts.	National Bearing Metals Corp.
	Plast-Silicon Powder	97 Si	Fineness and uniformity of the powder.	Incendiaries and pyrotechnics.	Plastic Metals, Inc.
	R-301	24 S clad with a new Al-Cu-Mg alloy	Corrosion resistance combined with extra strength.	Aircraft components.	Reynolds Metals Co.
	Revere Alloys M, FS-1 and J-1	Magnesium-base sheet, plate	Light weight, strength, machinability.	Aircraft and engine parts; vehicles; rapidly-moving machinery; portable tools; office equipment.	Revere Copper and Brass Inc.; Magnesium and Aluminum Div.
	Revere 24ST, 52SO, 61ST	Aluminum alloy tubing	24ST has highest strength, 52SO best corrosion resistance.	Structural aircraft members; gasoline, oil and hydraulic lines.	
	Revere Nos. 436, 437, 439	Aluminum bronze rods (436 contains Si)	High strength alloys. Tensile of cold drawn 437 exceeds minimum of AMS 4630-A.	Aircraft fittings, pole line hardware, etc. No. 439 for high-strength forgings.	Revere Copper and Brass, Inc.
	Tantung G2	Co-Cr with carbides of W, Ta and Cb	Harder than Tantung G.	Used successfully in machining aluminum and magnesium alloys.	Vascoloy-Ramet Corp.; Fansteel Metallurgical Corp.
POWDER METALLURGY PRODUCTS	Alloy 112	Mostly W	Forgeable; high specific gravity.	Rotors, gyroscope parts, etc.	Callite Tungsten Corp.
	Alloys 114, 114A; Type ST	Mostly W-Ag	High conductivity.	Electrical contacts.	
	Alloys 114, 114A; Type CT	Mostly W-Cu	High conductivity.	Electrical contacts.	
	Alloys 119, 119A; Type ST	Mostly Mo-Ag	High conductivity.	Electrical contacts.	
	Alloys 119, 119A; Type CT	Mostly Mo-Cu	High conductivity.	Electrical contacts.	
	Alloy 125-9	Mostly W	Spec. gravity: 19.2.	Contacts and other parts.	
	Alloy 225-9	Mostly Mo	Special electrical properties.	Contacts and other parts.	
	Brass Powder	60/40 to 90/10 Cu-Zn	Good physicals plus corrosion resistance.	For making strong, dense or porous compacts.	The New Jersey Zinc Co.

NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NOMINAL COMPOSITION	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
POWDER METALLURGY PRODUCTS	Elkonite D52, D53	97.5 and 95 Ag, Bal. CdO	Resistance to welding under heavy electrical loads.	Electrical contacts.	P. R. Mallory & Co., Inc.
	Elkonite G-12	Ag-WC	Resistance to arcing.	Electrical contacts.	
	Elkonite D-916	WC base	Very wear resistant.	Electrical contacts.	
	Kennametal K2S	Tungsten-Titanium carbide	Strong grade 91.5 RA hardness. Good abrasion resistance; moderate crater resistance.	Tool tips for roughing steel castings and cast iron.	Kennametal, Inc.
	Kennametal K6	Tungsten carbide	92.2 RA hardness. Good abrasion resistance; moderate impact strength.	Tool tips for general use on cast iron, softer metals, plastics.	
	Pomet 117-B	95 Cu, 5 Sn bronze	Good density, wearing properties, machinability and ductility.	For electrical and mechanical instrument parts at low cost.	Powder Metallurgy Corp., Division of General Bronze Corp.
	Pomet 127	70 Cu, 30 Zn brass	Good ductility, machinability, finishability. Can be plated if necessary.	Mechanical parts weighing up to 2 oz.	
	Pomet 300	Pure iron	Magnetic properties approaching those of soft iron.	Pole pieces in indicating instruments and other equipment.	
	Plast-Sponge Powder	98 Fe	Compressibility and uniformity.	Bearings and mechanical parts generally.	Plastic Metals, Inc.
	Silver Powder	99.8 Ag, crystalline or amorphous	High purity, precipitated powders; available in both fine and coarser meshes.	For molding electrical contacts, refractory metal compositions, parts, etc.	Columbia Silver Products
	Tungsten XXX-A Powder	99.95 W	Very fine size (90% below 1 micron) and lot-to-lot uniformity.	Manufacture of carbide tools.	Reduction and Refining Co.
	Tungsten XX powder	99.9+W	Uniformity of particle size.	Electronics materials.	

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
NON-METALLIC MATERIALS OF CONSTRUCTION	Ceratherm	Stoneware	Resistance to thermal shock and corrosion.	Tanks, jars, pots, fans, pumps, etc.	U. S. Stoneware Company
	Durashield	Laminated plastic	Can be die cut, stamped and drilled; withstands temperatures of 200° F.	Alternate for brass and bronze in nameplates, tool checks, etc., on ships and machines.	Plastic Fabricators, Inc.
	Karbate	Impervious graphite	High resistance to chemical attack and thermal shock.	Globe valves for highly corrosive liquids.	National Carbon Co., Inc.
	Insidline	Amosite and diatom earth mixture	A metal-retained insulating block lining. Permits pipe to carry pressure at high temperatures.	Process-industries equipment linings.	Baldwin-Hill Co.
	Lucite, Heat-Resistant	Methyl methacrylate molding powder	A molded transparent thermoplastic of higher heat stability than ordinary Lucite.	Flying light lenses, medical instruments, switchboard color caps.	Plastics Dept., E. I. duPont de Nemours & Co.
	Lumarith E.C.	Ethyl cellulose plastic	Dimensional stability, high impact strength, good engineering properties.	Molded parts that must be both light and strong.	Celanese Celluloid Corp.
	Melmac 1077	Melamine formaldehyde molding compounds; 1077 with alpha cellulose filler; P3020 and P3024 with chopped fabric filler, and P-592 and S-6003 with mineral filler	Water resistance and color.	Buttons, tableware.	American Cyanamid Co.
	Melmac P-3020 and P-3024		Water resistance, flexure strength, arc resistance, dielectric strength.	Switch parts, circuit breakers, food trays, etc.	
	Melmac P-592 and S-6003		Arc resistance, dielectric strength, heat resistance.	Electrical insulating parts, ignition parts, etc.	

NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
NON-METALLIC MATERIALS OF CONSTRUCTION	Nylon FM-1	Injection-molding powder	Good mechanical properties, toughness, high softening temperatures under load. Low sp. gravity.	On complete allocation. Used for spools for aircraft instruments, switchette housing, etc.	Plastics Dept., E. I. du Pont de Nemours & Co.
	Plast-O-Ply	Duplex: Synthetic rubber plus resins	Acid and alkali resistant. Non-conducting. Can be quickly installed.	Chemical tank linings for pickling, electro plating and anodizing.	Heil Engineering Co.
	Textolite No. 11,500	Phenolic resin fabric	Laminated sheets of high flexibility.	Rotor slot linings.	General Electric Co., Plastics Div.
	Textolite No. 1420	Phenolic resin	Cast filled plastic materials, rapid curing.	Gage blocks, stretch dies, form blocks, jigs.	General Electric Co., Plastics Div.
	Tylox	Coupling Composition	Ease of application.	Pipe couplings.	U. S. Stoneware Company
DESIGN FINISHES AND COATINGS	Alaka 7986	Nitrocellulose lacquer	High resistance to solvents. Can be baked at 250-275° F. for 1 hr.	Sprayed on coatings.	Lacquer and Chemical Corp.
	Alaka F 183	Black wrinkle finish	Excellent wrinkle formation, though non-critical oil is used.	Spray coatings on instruments and other equipment.	
	Alronox	Blackener for zinc	Non-electrolytic, fast 212°F. process. Gives dull, dense, black, adherent, corrosion-resistant coating.	Blackening zinc and zinc alloy die castings, parts and surfaces.	Alrose Chemical Co.
	Amercoat 33	Synthetic coating	Liquid thermoplastic, applied by spray or brush. Combination of inert resins.	Corrosion protection of metal, concrete, wood, machinery, etc.	American Pipe and Construction Co.
	Anozinc	Anodic oxide on zinc	Improves corrosion resistance and appearance. Black and yellow.	Used on zinc coatings on steel and other metals.	United Chromium, Inc.
	Anti-Corrode	Rust-preventing coatings	Provides a durable corrosion-protecting film for ferrous and nonferrous metals.	Made in types for spraying, dipping, brushing and baking.	Cities Service Oil Co.
	Carbozite Overseas	Rust-protecting film	Brushed, dipped or sprayed. Dries in 30 min. Easily removed by naphtha.	For protecting metal parts or equipment in storage or shipment overseas.	Carbozite Corp.
	Copper and Brass Black	Chemical blackening treatment	Dull black, integral surface film.	Small brass and copper parts.	Mitchell-Bradford Chemical Co.
	Cosmoline 805	Rust-inhibiting mineral oil	Neutralizes perspiration from hands handling steel parts.	Protection of steel parts in process within a plant.	E. F. Houghton & Co.
	Cosmoline Brilco Grade III	Polar-type reconditioner	Displaces water by virtue of fast wetting properties. Leaves 0.0003 in. film.	Reconditioning parts exposed to sea water; protection of parts between machinings.	
	Cronak	Basic Cr chromate treatment for Zn and Cd	Adherent film; retards corrosion in conditions of slow drying, condensation, etc.	Zinc and cadmium-plated carburetors, ordnance parts, instruments, etc.	The New Jersey Zinc Co., licensor
	Durofilm	Polar base in a volatile solvent	Durable, rust-protecting, either indoors or out.	For long time protection of parts and machinery.	F. E. Anderson Oil Co.
	Grey No. 102	Zinc dust base paint	Dull gray, resists water and corrosion.	Chiefly on the inside of cold water tanks aboard ship.	Thurmalox Co.
	Indium Plating Baths: Cy-An-In, Dex-Sol-In, Fam-Sul-In, Flo-Bor-In, Flo-Sil-In		Specially compounded plating solutions for indium coatings of controlled quality.	Bearings, propeller blades, etc.	The Indium Corp. of America
	Iridite	Bichromate solution	Produces an olive-drab coating; withstands over 200 hrs. salt spray.	Zinc and cadmium surfaced parts.	Rheem Research Products, Inc.

NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
DESIGN FINISHES AND COATINGS	Lead-Lined Steel	Sheet lead and sheet steel	Absorbs X-rays and serves as protective material with a finished surface.	Worker-protection in X-ray rooms.	Bar Ray Products, Inc.
	Lead-Sealed	Lead-coated steel	Lead alloy coating provides ideal surface for painting. Withstands forming operations.	Duct work, farm and poultry equipment, etc.	Continental Steel Corp.
	Lustre Black	Blackening salt	Used as a molten bath for coloring. Breakdown is very slow.	Coloring steel parts black.	A. F. Holden Co.
	Magnesodizing	Magnesium anodizing process	Alkaline process, A.C. or D.C., short time cycle. Good corrosion protection; can be dye-colored.	Protecting magnesium parts, and as a paint base.	Colonial Alloys Co.
	Meta-Clad	Heat-resistant coating	Protects ferrous metals from oxidation and destruction by fuel ingredients.	Brushed or sprayed on boiler, tubes, tuyeres, etc.	Armor Clad Co.
	N.C. Crystal	Black crystal finish	Made from currently available materials. Sprayed and baked onto work.	Instruments, ornamental finishes, etc.	Hilo Varnish Corp.
	Nukem Enamel	Phenol-Form-aldehyde coating	Dries in 15 min., without baking. Comes in range of colors.	Hoods, ducts, structural work, etc.	Nukem Products Corp.
	Pebble-Tex	Rough black coating	Lustreless, pebbly-texture finish. Usually applied over a primer.	Radio equipment parts, instrument panels, fire control, etc.	Egyptian Lacquer Mfg. Co.
	Pennsalt LF 42	Lead plating solution	Uses fluoborate iron for electro deposition of lead.	Plating aero engine bearings; barrel plating nuts, bolts; substitute for cadmium and zinc.	Penna. Salt Mfg. Co.
	Permite B. L. 109	Lacquer for Navy Spec. O.S. 1351	Red ammunition lacquer; dries in 3 min., has perfect adhesion, good coverage.	Sprayed coatings on projectiles.	Aluminum Industries, Inc.
	Poroseal	Non-organic coating	Resists heat, corrosion, abrasion, acids, solvents. Produced in many colors.	For severe-service finishes.	Pemco Corp.
	Quaker Ferrocote 346 and 360	Rust-preventing oils and chemicals	346 gives clean, dry film; 360 clean, soft, adhesive film. Both easy to remove.	Combined cleaning and rust-proofing of steel parts.	Quaker Chemical Products Corp.
	Redi-Paint	Paint-base for galvanized iron	Passivates galvanized surface, gives it roughened toothy surface that holds paint.	Applied by hand or tank immersion.	Turco Products, Inc.
	Rip-pl "A" and "D"	Black ripple finishes	"A" is non-priority, produces medium, glossy design. "D" (on priority) has medium-fine dull pattern.	Sprayed-and-baked-on finishes for instruments, radio parts, etc.	Hilo Varnish Corp.
	Rust Avoid 214D and 332	Polar base in a volatile solvent	Water-displacing rust preventives.	214D protects parts indoors. 332 developed for use after blackening.	F. E. Anderson Oil Co.
	Silco	Inorganic (vitreous) coating	Sprayed-on; provides resistance to corrosion, abrasion and heat.	Finishing stone parts, exhaust manifolds, ovens, etc.	Mitchell-Bradford Chemical Co.
	Stanorust 3-D	Rust preventive; polar type	A naphtha-base compound inhibiting fingerprint corrosion.	Indoor storage and protection of steel parts during processing.	Standard Oil Co. (Indiana)
	Sterling Flame-Resisting	Insulating Varnish	Flame-resistant varnish; mechanically strong, will not melt or resoften.	For class B high-temperature insulation; e.g. windings of large electrical units.	Sterling Varnish Co.
	Sublan	Rust-protecting paste	A low-priced lanoline substitute with anti-corrosion properties.	Protective coating for metal parts.	Glyco Products Co., Inc.

NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
DESIGN FINISHES AND COATINGS	Turco L-712	Black Oxide	Comes in powder form; produces blue or black oxide finish on steel.	Spark plug shells, ordnance parts, etc.	Turco Products, Inc.
	Turco Rust Avert	Rust preventive	A liquid. Produces dry greaseless, rust protecting film.	Protecting metal parts from rust in outdoor storage.	
	Unichrome Alkaline Zinc	Zinc plating bath	Produces smooth, fine-grained zinc deposits at high speed.	Zinc plating on all metals commonly plated.	United Chromium, Inc.
	Wax S254	"Soluble" wax	Readily removable by water.	Protective coating for aluminum castings.	Glyco Products Co., Inc.
	Zinc Black	Blackener for zinc	Produces dull, black finish on zinc and zinc alloy die castings.	Ordnance and other zinc or zinc-surfaced parts required to be black.	Mitchell-Bradford Chemical Co.

NEW PROCESSING MATERIALS FOR THE METAL INDUSTRIES

Developments among metal-processing materials have come so fast in 1943 that this section of M&A's "New Materials" Table is more than twice as long as the corresponding section published in our Annual Engineering Review issue of a year ago. Because of its new length, we have sought to facilitate the reader's use of the section by subdividing it into groups of materials according to the type of process in which the materials are used. These process-groups are

MACHINING AND METAL-WORKING • CLEANING AND FINISHING • HEAT TREATING • MELTING AND CASTING
REFRACTORIES AND INSULATION • WELDING, BRAZING, SOLDERING AND CEMENTING

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
Materials for MACHINING AND METAL-WORKING	Acme Layout Dye	Purple Dye	Semi-transparent fast-drying. Soluble in denatured alcohol.	Brushed on sheet metal, the purple die may be scribed for layout, the scribed lines being very clear.	Acme White Lead & Color Works
	Ad-Lea-Sive	Polishing Wheel Sizing	Blue base, applied in bar form to wheel by friction.	Improving life and performance of polishing compounds.	The Lea Mfg. Co.
	Cut-Aid	Cutting Oil	Compounded petroleum oil; gives improved finish and tool life.	Machining of aluminum, magnesium and other nonferrous metals.	Gulf Oil Corp. Gulf Refining Co.
	Cut-Max H. S.	Cutting Oil	Straight mineral base; thin, colorless, high heat absorption and flash point.	For all machining of magnesium where a cutting oil is needed.	E. F. Houghton & Co.
	DC 50	Cutting Oil	Active sulfurized-base; non-corrosive to steel and copper alloys.	Machining of steel, stainless steel and other tough metals.	Diversey Corp.
	DC 52	Forming Compound	Non-corrosive, easy to apply and remove. Best on aluminum.	Forming operations on aluminum and its alloys.	
	Flexo Wax C	Forming Wax	Synthetic wax with lubricating properties and reducing action on oxides.	Lubrication and rust prevention of nickel alloy stampings.	Glyco Products Co., Inc.
	G-S-R No. 68	Forming Compound	Vegetable oils, water soluble; easy to clean and emulsify.	Drawing, stamping and forming of aluminum aircraft parts.	G. S. Rogers & Co.
	G-S-R No. 81-A	Cutting oil	Straight, sulphurized; clear, transparent, highly active.	Machining and cutting of various metals.	
	G-S-R No. 82	Cutting oil concentrate	Sulphur-chlorine concentrate; mixes cold, imparts e.p. virtues to cutting oils.	Additive to ready-mixed oils or as straight cutting-oil base.	
	G-S-R No. 84	Soluble cutting oil	Transparent; odorless emulsion with low surface tension that betters finish and tool life.	Grinding, machining and cutting of metals.	

NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
Materials for MACHINING AND METAL-WORKING	Hot Forging Agent 348	Forging lubricant	Graphited mineral oil; gives superior protection to forging dies.	Forging aluminum and magnesium alloys.	E. F. Houghton & Co.
	Jessop RT	Tool steel	Water-hardening tool steel with heat-treated t.s. of 323,000 p.s.i. and 4-5% elong.	Battering tools.	Jessop Steel Co.
	Kennametal Grade K2S	Carbide tools	Tungsten-titanium carbide with extra high strength but moderate water resistance.	Tool tips for roughing cuts on iron and steel castings.	Kennametal, Inc.
	Kennametal Grade K6	Carbide tools	Straight tungsten carbide; extra hardness, but only moderate impact strength.	Tool tips for machining cast iron, non-ferrous metals, etc.	
	Microgrind No. 132	Grinding compound	Contains no oil or soap; keeps wheels clean; drops chip rapidly.	All precision grinding and super-finishing.	Quaker Chemical Products Corp.
	SCO 5 SCO 10 SCO 20 SCO 30	Cutting oils	Transparent sulphur-chloride, high-pressure oils.	Threading and tapping.	Apex Alkali Products Co.
	Secomet	Grinding-wheel material	Diamond-bonded (resin bond with metal filler); Fast cutting, high finish.	Special for carbide tools, h.s. steels, etc. All grinding operations	J. K. Smit & Sons, Inc.
	Tool Kool No. 20	Cutting fluid	Super-fatted — emulsifier base and waxes and mineral oil. Outstanding wetting out, cooling and lubricating properties.	All machining operations, even those for which only straight oils were once used.	Quaker Chemical Products Corp.
	Vegicut A Vegicut B Vegisol Vegisulph	Cutting oils	Increased oiliness, copious wetting and cooling ability; resist rusting and rancidity.	Cover as a group the whole range of machining operations.	National Oil Products Co.
	Winsor Super Kut Soluble No. 3	Cutting oil	Incorporates a heavy-duty cutting oil in water to give an emulsion that cuts like oil and cools like water.	Milling, thread-milling, drilling, reaming, turning, etc.	F. E. Anderson Oil Co.
	WS-101 WS-102 WS-103	Cutting oils	Transparent, non-rusting.	Grinding, threading, tapping, etc.	Apex Alkali Products Co.
Materials for CLEANING AND FINISHING	Aluminum Cleaners 1, 2 and 3	Cleaning solutions	Rapid, uniform, harmless to surface	Especially adaptable for aluminum cleaning	Mitchell-Bradford Chemical Co.
	B.C.F.	Copper plating additive	Addition agent increases the hardness of copper plate, permits thinner deposits.	Copper electro-type printing plates.	Electroplating Div., E. I. du Pont de Nemours & Co., Inc.
	Bunatol	Plating rack insulation	Gives tough, adhesive coating that is flexible and does not crack when clips are flexed.	Especially designed for anodizing by either sulfuric or chromic processes.	Nelson J. Quinn Co.
	Cleaners 57 and 100	Alkaline cleaners	Contain surface-active materials. Fast acting with high rinsability.	No. 100 for anodic cleaning of steel; No. 57 for removing zinc chloride fluxes.	Enthone Co.
	Consisto-Weld	Spot-welding pre-cleaner	Uniformly etches aluminum to be spot-welded without damage to metal.	Spot welding of aluminum in aircraft and elsewhere.	Turco Products, Inc.
	D-C No. 16	Emulsifiable solvent	Safe; leaves temporary rust-proofing film.	Emulsion cleaning of iron and steel parts.	Diversey Corp.
	D-C No. 1	Acid cleaner	Safe, non-critical; attacks aluminum oxide.	Removing oxide film before spot welding aluminum.	
	D-C No. 12	Alkaline cleaner	Electro cleaner for use with reverse or d.c. No foam blanket.	Preparing surfaces for electro plating.	

NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
Materials for CLEANING AND FINISHING	Deox-Aluminum	Aluminum cleaner	Water-solution dip-cleans aluminum without etching underlying metal.	Used on all alloys; leaves protective coating on; also used as anodizing rack stripper.	Colonial Alloys Co.
	Dilac	Acid cleaner	Cleans and forms rust-resisting coating at same time. Good paint bond.	Cleaning projectiles and other steel parts before painting.	Diversey Corp.
	Diversey Aluminum Cleaner	Alkaline cleaner	Powerful but non-corrosive cleaner for aluminum and its alloys.	Cleaning before spot-welding, anodizing and painting.	
	Enthone Emulsion Cleaners	Solvents plus emulsifiers	Contain penetrants. Rapidly remove oil and solid dirt from all metals.	Cleaning badly contaminated metals.	Enthone Co.
	Fas-Tin and No. 20	Hot-tinning fluxes	Fluxes for hot-dipped coatings high in lead and low in tin and zinc.	Fas-Tin for 500-750° F.; No. 20 for 800-850° F.	Hanson-Van Winkle-Munning Co.
	Oakite No. 86	Acid cleaner	Efficient degreaser; lightly etches steel, provides base for paint; leaves rust-protecting coating.	Preparing shells, switch-boxes, powder cans, radio chassis, etc. for painting.	Oakite Products, Inc.
	Pennsalt A-10	Alkaline detergent	Mild alkaline action. Cleans metals without harming the surface.	Spray type power washing of aluminum and other non-ferrous metals.	
	Pennsalt E. C. No. 2, E. C. No. 10	Emulsion cleaners	E.C. 2 is a concentrate; can be extended with kerosene. E.C. 10 can be applied cold; very efficient.	Pre cleaners before alkaline cleaning and painting. E.C. 2 also a rust inhibitor.	Special Chemicals Div., Pennsylvania Salt Mfg. Co.
	Pennsalt P. M. No. 40	Pickling agent	Acid-soluble, highly stable. Reduces acid consumption, metal loss. Good in low concentrations.	In both sulphuric and muriatic acid pickling of iron, steel.	
	Prosolv B	Electro-cleaner	Deeply penetrating; gives chemically clean surface.	Cleans and strips tin in Bullard-Dunn cleaning and in plating processes.	Turco Products, Inc.
	Solventol	Cleaner and conditioner	Removes smut, dirt, abrasives and lead; protects against finger marks; prevents rust.	Cleaning and rust protection of metal parts.	Solventol Chemical Products, Inc.
	Turco Skinner	Paint remover	Water-soluble, non-inflammable liquid.	Removing paint from aircraft and marine surfaces and all metals.	Turco Products, Inc.
	Unichrome Coating 202	Rack insulation	Resists acids, alkalies and anodizing solutions.	Insulation of plating racks.	
	Unichrome Stop-off 311	Plating stop-off	Resists boiling cleaners, acid dips and hot plating baths.	Stop-off of work being plated.	United Chromium, Inc.
	Unichrome Stop-off 323	Rack insulation	Quick drying. Readily peeled off after use.	Insulation of plating racks, especially for hard chromium.	
Materials for HEAT TREATING	No. 200 Quenching Oil	Mineral oil	More rapid quench than conventional oils.	Quenching of N.E. steels.	Park Chemical Corp.
	Alcarb	Fluid case hardener	Used with gas carburizing furnaces, to give any desired case depth.	Gas carburizing of steel parts.	Ecco Chemical Corp.
	Flow Heat	Liquid bath hardener	Develops unusually high physicals in steels treated.	Salt bath hardening of alloy steels.	A. F. Holden Co.

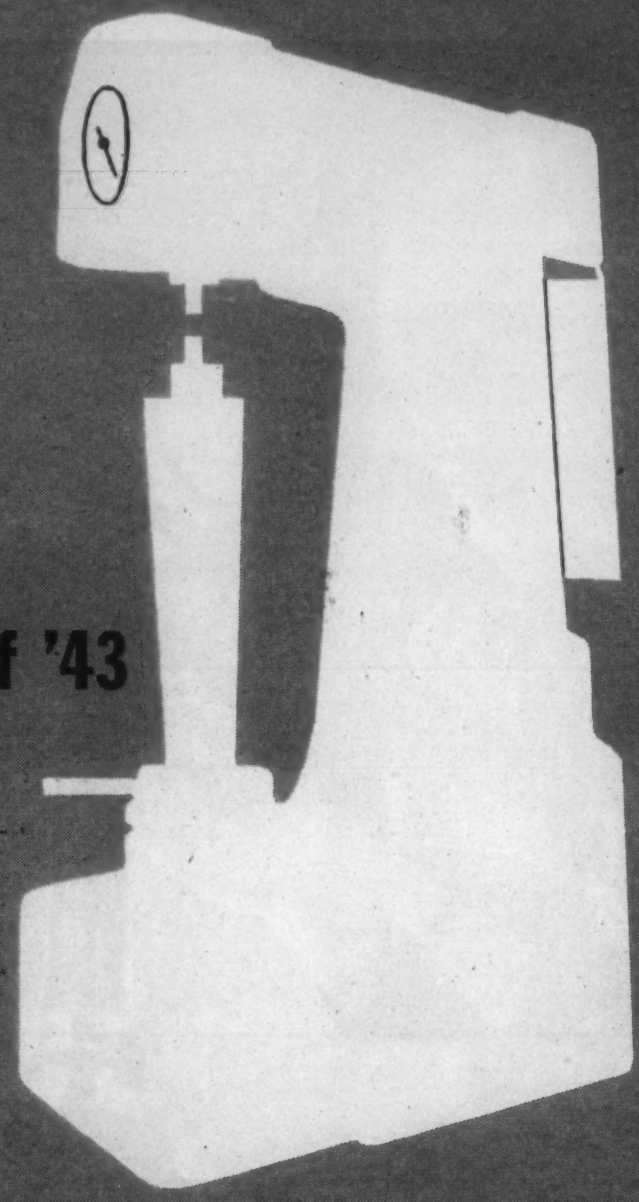
NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
Materials for HEAT TREATING	G-S-R No. 15	Pack carburizer	Light weight, minimum dust, fast penetration.	Case hardening of wear-resisting steel parts.	G. S. Rogers & Co.
	G-S-R No. 20-B	Quenching oil	Contains inhibitor. Maximum cooling properties permit fastest quenching.	Quenching N.E. steels, heavy pins, forgings, etc.	
	G-S-R No. 38	Liquid bath carburizer	An activated, one-bath mixture, forms own carbon cover; fast; low drag out.	Liquid carburizing of gears, pins and bushings.	
	G-S-R No. 39-B	Neutral salt bath	Chiefly a nitrate bath with freedom from metal attack.	Heat treating of aluminum alloy aircraft sheets and parts.	
	Insulite	Stop-off paint	Metallic-base paste. Neutralizes effect of carburizing atmosphere on coated sections.	For selective carburizing of steel parts.	E. F. Houghton & Co.
	Mar-Temp	Quenching salt	Molten at 400° F. Rapid quench thru critical zone; stable, no sludging.	For "interrupted" quenching from hardening temperature into molten salt—used for distortion-less quenching of lean alloy steels.	
	Nitron	Cyanide bath	A heat treating salt that provides a rapid, light ultra-hard case.	For case-hardening high speed cutting tools—200% increase in life.	Ecco Chemical Corp.
	No-Kase No-Tride	Stop-off paints	Both are metal pigments in organic vehicles for selective case-hardening. No-Kase gives positive protection against carburizing in liquid baths, No Tride against nitriding in ammonia atmospheres.		Park Chemical Co.
	Nu-Carb	Pack carburizer	Non-burning coke base. Reused with minimum replenishment.	Pot carburizing of steel parts.	E. F. Houghton & Co.
	Quenchol	Quenching oils	Refined petroleum oils, with excellent quenching and tempering properties.	All oil quenching and tempering operations.	Sinclair Refining Co.
	Satin Finish	Protective copper plating	Plating process to protect tools and parts from scaling, decarburization, etc. during hardening.	Heat treatment of high speed steel.	Alfred Heller Heat Treating Co.
	Speed Nitride	Salt and gas	Salts bath and gas used together for rapid nitriding.	Nitriding steel parts.	A. F. Holden Co.
	Super-Quench	Quenching oil	Provides a rapid quench, maximum physicals, minimum distortion.	All types of quenching operations.	Gulf Oil Corp.; Gulf Refining Co.
Materials for MELTING AND CASTING	A.B.C. Foundrates	Refining fluxes	A series of fluxes for purifying, degasing, dedrossing, deoxidizing all commercial metals.	Refining aluminum alloys, copper alloys, nickel alloys, cast iron, steel, scrap and drosses, etc.	American-British Chemical Supplies, Inc.
	Foseco Aluminum De-Gaser	Refining agent	Degases and refines grain of aluminum castings.	Aluminum alloy castings.	Foundry Services, Inc.
	Foseco "R6"	Refining agent	Purifies, degases and improves copper alloys.	Gun metal, tin bronzes, etc.	
	Foseco Corecoats	Core dressing	Has porous enamel finish. Produces clean castings.	Both nonferrous and ferrous castings.	
	Grainal Nos. 1, 6 and 27	Intensifiers for steel	Addition agents to increase the hardenability of steels. No. 27 contains no vanadium.	Various grades of low-alloy steels.	Vanadium Corp. of America
	Hy-Ten	Oilless core binders	Powder; reduces core-baking time, improves finish; collapses rapidly.	Types for cores for iron, steel and nonferrous casting.	E. F. Houghton & Co.

NEW MATERIALS AND FINISHES OF 1943

TYPE OF MATERIAL	TRADE NAME OR DESIGNATION	NATURE	OUTSTANDING CHARACTERISTICS	APPLICATIONS	MANUFACTURER
Materials for MELTING AND CASTING	National Riser Rods	Graphite riser rods	Readily soluble in the riser metal.	Risers for all types of steel castings.	National Carbon Co., Inc.
	Plast-Iron Melting Stock	Pure iron	99.95% iron briquets made by direct reduction.	Melting stock for high grade steels and alloys.	Plastic Metals, Inc.
REFRACTORIES AND INSULATION	Close Pore	Aluminum silicate	High resistance to both heat and chemicals.	Ceramic pots.	A. F. Holden Co.
	Ironton Nojoint	Ramming refractory	Plastic ramming refractory.	Lining receiving, mixing, desulfurizing ladles.	Ironton Fire Brick Co.
	Magnehearth	Ramming mix	Dead-burned magnesite (80% MgO) with bond. Accurate grain sizing, density of about 170 lbs./ft.^{3}	Open hearth and electric furnace bottoms and bottom patching.	General Refractories Co.
	Taylor Zircon	Zircon refractory products	64% ZrO_2, 34-SiO_2. High refractoriness. Not "wet" by metallic aluminum or its dross.	Bricks, shapes and cement for hearths, side walls of aluminum melting furnaces.	Chas. Taylor Sons Co.
	Thermex 400	Coating for furnace walls	Protective coating for refractory walls; prolongs furnace lining life.	Brushed or sprayed on to furnace linings.	Armor Clad Co.
	Thurco No. 22	White gloss coating	Coats insulating materials; acts as a fire-retardant.	For insulation, covering, insulation boards, etc.	Thurmalox Co.
Materials for WELDING, BRAZING, SOLDERING, CEMENTING	Cyclewelding	Resin bonding process	Fast setting, mass-production, high-strength adhesive.	For cementing metals to each other and to nonmetals.	Goodyear Tire & Rubber Co.; Chrysler Corp.
	Flo-Ez-Flux	Welding flux	Free-flowing flux; will not solidify or deteriorate.	Gas welding wrought or cast aluminum alloys.	Park Stewart
	Lloyd No. 6	Soldering fluid	Efficient action; aids lead-rich solders to flow into inaccessible places.	Soldering zinc, lead and tin-coated sheet; copper alloys, steel, etc.	Lloyd S. Johnson Co.
	Mag-na-Flo	Welding flux	Mixed into thin paste with water, painted on with brush.	For gas welding magnesium alloy sheet or extrusions.	Park Stewart
	Matrix Duplex Compound	Brazing material	A mixture of flux and powdered brazing alloy. Paste is brushed on metals joined.	Torch or furnace brazing of cutting tips to tool shanks.	American Products Corp.
	Murex A Murex R-C Murex C-F	Welding electrodes	Type "A" is a mild steel electrode for a.c., all-position arc welding, "R-C" and "C-F" are low-alloy high-strength electrodes for repair of air-hardenable steel castings.		Metal & Thermit Corp.
	No-Spat	Spatter removal aid	Liquid. Brushed on area where weld spatter may fall, permits wiping off spatter later.	All welding operations, especially where reduction of spatter and saving of rod metal are important.	Midland Paint & Varnish Co.
	Reanite	Synthetic cement for metals	High bonding strength, ease of application, fast working.	Joining metal, rubber and synthetic to metal.	U. S. Stoneware Co.
	Scaiflux 21	Silver brazing flux	Fully active at 900°F., yet stable above 1650. High melting power, easily washed.	All types of silver alloy brazing.	Scaife Co.
	Silver Series	Welding electrodes	Hard-surfacing electrodes of unusually high hardness.	Rebuilding and hard-facing cutting edges and tools.	American Agile Corp.
	Tygonite	Cement for metals	Synthetic adhesive with high-strength, cold-setting bond.	Cementing metal, rubber and synthetics to metal.	U. S. Stoneware Co.
	Unichrome Cements 600 and 601	Corrosion resisting cements	600 is air-drying liquid, resists water and chemicals. 601 is solid, applied after melting; resists acids, alkali.	600 cements plastic insulants; 601 for smooth surfaces, glass, metal, etc.	United Chromium, Inc.
	W-26	Arc welding electrode	Deposits weld metal in vertical and overhead positions with a.c.	Shipbuilding and other a.c. arc welding of mild steel to meet E-6011 spec.	General Electric Co.

Engineering Review of '43



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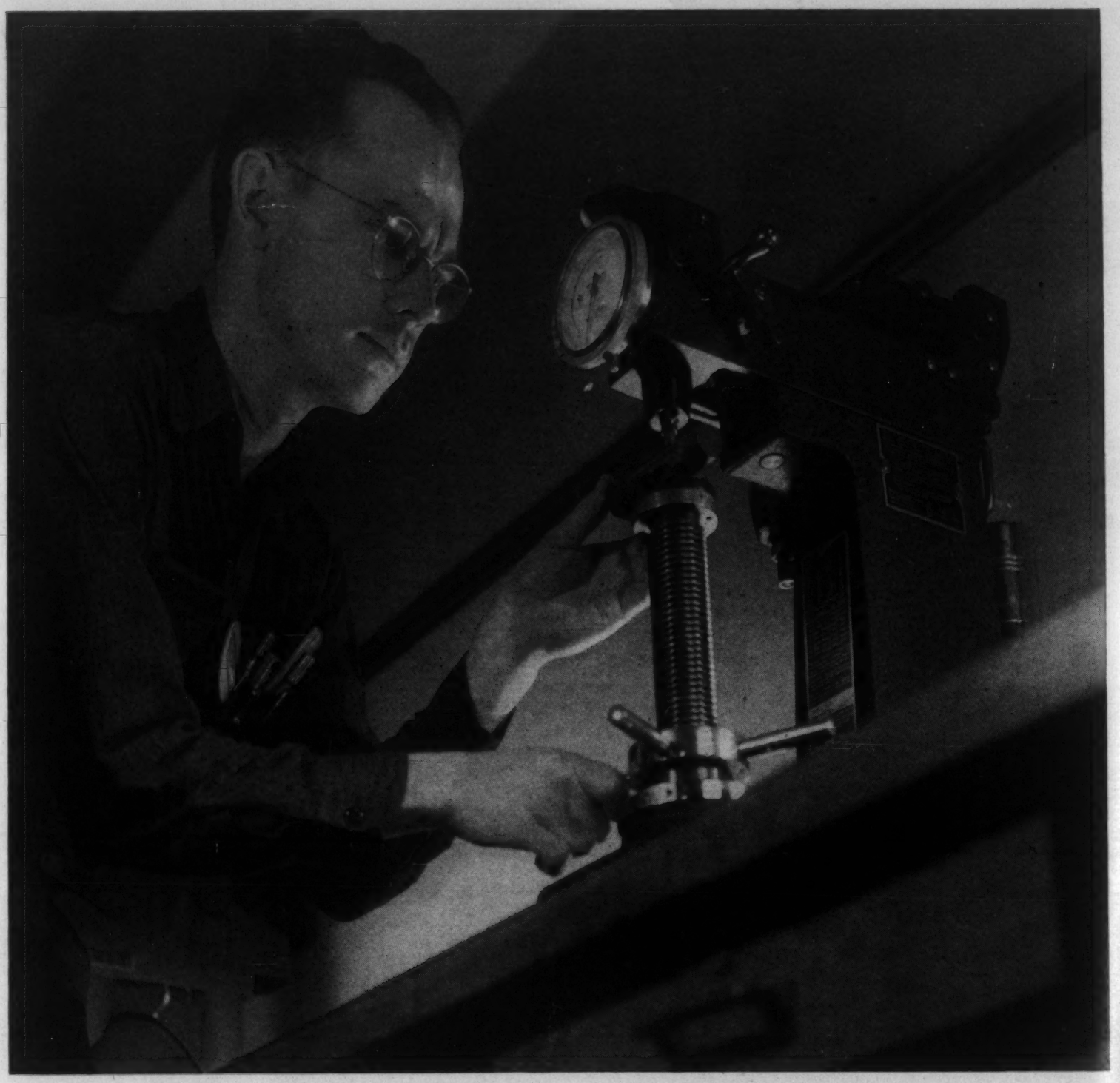

Taking Rockwell "C" readings on the ground surface of a Jominy hardenability testpiece. (Courtesy: Jos. T. Ryerson & Son, Inc.)

Magnetic and Electrical Inspection

by R. R. Moore

Chief Metallurgist, Naval Aircraft Factory, Philadelphia

War time requirements have greatly emphasized the importance of rapid non-destructive methods of testing important and critical metal parts. The rapid and mammoth production of the war industries has been an outstanding incentive to the development of such types of tests. Test methods based on magnetic and electrical principles have been particularly valuable in this field and considerable progress has been made in the extension of their use.

A very important improvement in this field occurred with the introduction of the Magnaglo method of performing the well known Magnaflux test. Magnaglo operates on the same basic principle but the visibility of the indication is greatly improved when observed under ultra violet light because the special powder used in this method is treated to make it fluoresce under the action of the light. The particular advantage of Magnaglo is that in-

dications in dark holes, deep grooves, on blackened, scaly and rough surfaces are made much more readily visible; also very fine indications on normal surfaces that are difficult to see when developed under the standard Magnaflux method are readily apparent under Magnaglo. It has been the practice in some plants to coat rough forgings with a light coat of primer previous to Magnaflux to make the indications more readily visible. The use of the Magnaglo method eliminates the necessity for this operation.

While inspection for defects in magnetic alloys is reasonably well covered by the Magnaflux method for many requirements, there is still a demand for a good practical method of locating defects in non-magnetic alloys. Various electrical methods have been proposed but few of them have gotten beyond the experimental stage. One of the most promising appears to be a recent modification of the Sperry electrical tubing tester announced a few years ago. This system, originally developed for steel tubes, has been advanced to the point where it has some application in the non-ferrous field. Basically the detection of longitudinal defects is indicated by their effect upon an alternating current induced in the alloy under test. It can be used on solid bars as well as tubes and is applicable to magnetic steels and the non-magnetic stainless steels as well as non-ferrous metals.

The method developed by the Magnetic Analysis Corp. which has been in practical use for the last 15 yrs., is constantly obtaining broader application. This method employs both magnetic and electrical principles and also utilizes the effect of the defect on an induced alternating current, but is generally only applicable to magnetic alloys.

An active demand has existed for a long time for a method that will identify or sort mixed stocks of steel bars, sheet or tubes. A recent electrical method sponsored by the Dravo Corp. is particularly adaptable to this type of work. It is based upon the principle of the thermocouple—that if two conductors are connected in a circuit so that they have a mutual point of contact and the temperature of the point of contact is raised or lowered beyond the temperature of the two remaining junctions, an EMF will be generated if the conductors are of dissimilar chemical composition.

In its simplest form, small bars to be sorted or identified are contacted at one end, and a heating current is passed through to create a rise in temperature at the junction. A sensitive instrument connected to the other ends of the bars indicates whether an EMF is developed. Combinations of bars that show no EMF are considered to be of the same chemical composition.

Another very recent development in this field of sorting and identification is the Cyclograph sponsored by DuMont Laboratories. This method of test has been used to identify such properties as hardness, case depth, decarburization, stress gradients, etc. The method is based on core loss characteristics as indicated at various frequencies.

By using several frequencies and plotting the results, it is possible to eliminate the effects of properties that are of no interest for the particular purpose at hand and might operate to counterbalance important properties. This instrument is extremely flexible and if successful promises to open up a wide field in non-destructive testing of finished parts to determine many of the properties that are now checked by destructive testing of samples.

Mechanical Testing

by H. S. Rawdon

Bureau of Standards, Washington, D. C.

The year 1943 was characterized by refinement of methods to promote greater production rather than by outstanding developments of new apparatus or methods. The desire to get the maximum amount of information by present methods has continued dominant. Many of the restricted reports of War Metallurgy Committee contain pertinent information on the general subject of this section.

Hardness.—The microhardness tester (Knoop or Tukon) has been improved by an automatic device to eliminate loading error caused by beam inertia. Although mechanically operated hardness indentors are not new, improved forms are reflected in the claim that as many as 2400 determinations per hour are being made. Hardness conversion tables for steels have been covered by ASTM specifications and a comparable Federal specification is imminent. Despite condemnation of previous forms the portable hardness indentor will "not down." A new form is proving useful for soft metals.

Tensile.—The Tin Research Institute announced a new machine for testing metal foil, in tension, freedom from specimen tearing being the marked advantage claimed. The commonly-used lap joint in testing soldered and welded sheet has an inherent fault, since truly axial loading is not attained. Bureau of Standards tests indicate a scarf joint to be far superior for solder testing. High-speed low-temperature tests at Watertown Arsenal have continued to give valuable information on the effect of loading speed on tensile p-limit, ultimate tensile strength, and reduction of area.

A small hand-operated tensile tester has found favor especially for spot-welded sheet aluminum-alloy. Study of tensile-elastic properties of work-hardened aircraft metals has continued at the Bureau of Standards for NACA, and for the same organization, the seldom-used bearing test for sheet metal (dimensional change in hole through which passes the loading pin) has given useful information for airplane design. The

deForest wire strain gage nas proved useful in determination of residual stresses in rather complex cast shapes. Compressive properties of sheet metal, an important subject in airplane design, can be determined on a single specimen supported by a simple device soon to be described by the Bureau of Standards.

Fatigue.—By using the device just mentioned it is possible to determine endurance limit of sheet metal under axial tension-and-compression loading. A flexural fatigue test of sheet stainless steel following exposure corrosion has proved a satisfactory novel means of evaluating the effect of corrosion on this structural material. According to the ASTM Fatigue Research Committee, 1-in. diam. is critical in the size-vs.-endurance study. Increase beyond this diameter does not materially reduce the endurance limit of notched or plain specimens further.

Creep.—Wide use has been made of stress-rupture tests to obtain design data quickly. A new autographic device from the General Electric Research Laboratory utilizes a light beam passing through 2 fine grids of horizontal lines to measure creep. Movement of one grid relative to the other causes fluctuations in beam intensity which are automatically counted and recorded by a photo-cell and auxiliary equipment. The so-called hyperbolic sine function for expressing relation between creep rate and stress at constant temperature appears to have marked advantage for low stresses.

Wear.—A new wear gage available during the year appears useful for study of engine cylinder wear. Observations are made on dimensional changes in indentations similar to Knoop hardness indentations in the surface under study. Results on steel are more satisfactory than those on cast iron.

Impact.—War time needs have directed developments in this field with wire strain gages and recording oscillographs utilized for studying variation of load with time and high-speed motion picture and flash photography to record deformation of specimens during impact. A method to utilize a Brinell impression in measuring impact loads appears promising.

Radiography

by Alexander Gobus

Chief Metallurgist,
Sam Tour & Co., New York

The progress in the non-destructive examination of castings and weldments that is being made is illustrated by the frequent well attended meetings of Committee E-7 on Radiography of the A.S.T.M. and the rapid growth and excellent programs of the local groups of the American Industrial Radium and X-Ray Society. Many details of the latest developments can be found in the volume entitled "Symposium on Radiography, 1943," published by the A.S.T.M.

Radium radiography advanced considerably. It is estimated that about double the amount of radium used in 1942 was used in 1943. Many tens of grams are constantly active. The U. S. Navy standards of 1938 have been modified and are a useful guide to all concerned with interpretation of gammagraphs.

R. C. Woods has described a rapid exposure technique wherein one of the usual lead screens is replaced by one screen of calcium tungstate. The writer has described the roll film technique whereby the use of single lengths of film up to 6 ft. in length are exposed at one time.

In radiography by X-rays, tube development has slowly and steadily reached the stage where operation of machines is on a continuous 24-hr. per day basis with continuous flow of material for inspection past the tube. Some installations use the greater density resulting from defective articles to automatically notify the operator of the fact by an electronically operated signal.

The recording of images on photographic film by photography of the image on a fluorescent screen has found some success in medical work. Units are now available for industrial work using film from 35 mm. movie type up to 4 x 5 in. This should be a great economy provided contrast and sensitivity are suitable for the subject matter.

An improved flexible film holder is now available which should find wide application, especially around foundries.

A prominent place among the advances for the year is due the high intensity illuminator operated with photo floodlamps. A variable transformer varies the light intensity and such refinements as double glass and cooling systems make dense films easy to read. Overall film quality is better at densities higher than the 0.7 to 1.1 H & D values previously used.

Exographs often were of value only for part of a casting and two, three, or four were sometimes required for a complete examination of a single plane. It is now possible in many cases to view a single film. The net result has been to increase the latitude of a film and the range of the radiation source.

The erstwhile method of blocking is being slowly replaced by suitable filtration placed in the primary beam. Reduction of undercutting or scattering is accomplished by this method.

Radiography by X-rays is perhaps highlighted by the development and application of the 1,000 KVP self-contained unit. A large number of these units are in service and seem destined to supplant the previously popular 220 KVP unit.

Microradiography of thin metal sections magnified up to 200X have been exhibited, and show such features as micro shrinkage and segregation.

An exposure meter for X-ray described by Friedman and Christenson is being found applicable to radium radiography as well.

Fluoroscopy of die castings and other light alloys formerly thought of as being limited to a sensitivity of some 10 to 15 percent is now said to be possible of accomplishment under ideal conditions with a sensitivity of 3 to 5 percent.

Still in the development stage are the following: A new unit for research work, capable of producing 100,000,000 volts; the Betatron, operating at 19,000,000 volts, which is said to penetrate 24 in. of steel with a 5-min. exposure; and high-speed radiography capable of fast enough exposures to stop armor piercing bullets while entering test plate. To date this equipment is limited to steel not over 1 in. thick.

Also still in the experimental stage but possible of interesting applications are at least three different experiments in the New York area. Each aims for definitely locating defects on a single film. The laminographic method depends on movement during exposure. The trivisional method uses reticulated film such as used for photography. A new stereoscopic method being developed for medical and dental uses may find some industrial use. None of the three methods has as yet reached the stage where they may be termed advancements in the art of radiography as applied to inspection of welds and castings.

Instrumentation

by L. G. Bean

Vice President in Charge of Engineering,
The Bristol Co., Waterbury, Conn.

In reviewing the instrument development for 1943, one can break it down into those which cover new developments of instruments themselves and secondly, into newer or increasing applications for instruments. War activities have channelled a lot of instrument development work along specialized lines; nevertheless, industrial instruments have shown improvement and promise to show considerably more.

In the field of instruments themselves, the increased use of electronic control is notable. Most of the electronic means have been in the realm of control rather than in that of measurement. This is shown with improved pyrometer control and with the bringing out of new thermometer controls, substituting electronic control in place of mechanical type mercury switch control. Their advantages are simplicity and freedom from moving parts; great strides have been made in the reliability and freedom from effects of variation in tube characteristics when replacement is called for. New developments portend an increase in the use of electronics in measuring elements.

Another field in which instruments have been considerably improved is in the pneumatic control field where they have been increased in variety, possibly to give the consumer a better selection for adaptability to any specific job.

Great interest has also been shown and improvement in design made with the placing on the market of an improved dilatometer, which gives a time dilation and temperature curves in rectilinear coordinates. These curves allow the critical points of ferrous metals to be easily determined and also show the correct heat treatment, including quenching, for any given specimen. Their use can also be made to determine coefficients of expansion and help determine alloyed ingredients of the sample. Great strides are expected in the adaptation of these methods to heat treatment in the near future as the use of these instruments becomes known to more engineers.

In the field of application of instruments, a considerable increase in instrumentation has taken place in the open-hearth field, in regard to both temperature and draft control, and by both electric and hydraulic means. The start of this dates back a number of years, but the war has given further impetus to the use of these instruments.

All stressed parts going into many aircraft are 100 per cent X-rayed. This battery of Triplett & Barton X-ray machines at a Lockheed plant is well able to support this rate of inspection.

The control of salt baths for blackening has also greatly increased, particularly where this process has been used to replace war-time prohibitive plating jobs. Greatly improved results have been secured by adding control to these baths, whether they be gas-fired or water-heated.

In the process industries, a change, which may well spread to some heating processes, is notable in the increased use of ratio and autoset controls. In the latter, the control point of one instrument is set by a second instrument, all suitably protected to allow for emergency conditions when either instrument can take on control alone.

In recent years, a great deal more pneumatic control has been applied very successfully in the metal industries, and its ease of operation and freedom from moving parts has much to recommend it for many jobs.

War-time labor shortages have increased the use of much control in order to help reduce labor and that is one of the functions of control. In the near future, its secondary function—to improve costs—will also come into greater play. As our war-time demand for instruments may slacken off, industry can again get a bigger share of not only its requirements but its refinements in the way of control.

Metallography

by L. L. Wyman

Research Supervisor, War Metallurgy Committee, Washington

Progress in the field of metallography during the past year has been evidenced by much wider general application of microscopic methods, by appreciable improvements in technique, and by intensive efforts to apply some of the newer metallographic tools.

The tremendous expansions in the metal industries have created a severe demand for microscopic equipment. These requirements, coupled with curtailed product availability, have limited the expansion of the use of large metallographic microscopes, and have fostered the return to small units.

Several laboratories have solved this problem by building up small compact units capable of visual examination and of photography up to 500 or more magnification. Some of these units are very well designed, and the success of such units bids fair to give them an established place which, in the hands of the individual investigator, will relieve the larger equipment from the more routine work.

In laboratory technique, material improvements have been achieved by means of the availability of excellently designed accessory equipment for sample cutting, grinding, and rough polishing. The increased use of wet methods of coarse polishing, fostered by better materials and equipment have made possible the more rapid production of better prepared samples. Lack of imported silk and wool seriously affected the availability of suitable polishing cloth, but this resulted not only in the production of satisfactory domestic material, but also gave impetus to the use of the new "synthetic" cloths.

Electrolytic polishing is used to a much greater extent. The polishing solutions now recommended are far safer than those originally suggested, the operation is quite rapid when once standardized, and the resultant polished surface should be entirely free from "flowed" metal. This last factor is of extreme importance in work at high magnifications and with electron microscope applications.

The greater attention being paid to local variations in microstructure because of their association with local hardening, microcracks, etc., has not only required more painstaking sample preparation and study, but has resulted in quite widespread use of micro-hardness testing. Resultant correlations have repeatedly proven to be of much value in studying the causes of difficulties encountered in case hardening, welding, solution heat treating, and similar applications.

Structural analysis by X-ray diffraction, electrical and magnetic determinations, specific heat, and other physical phenomena have increased materially and are now well recognized means for the study and control of the metallographic condition in metallic materials. While not new, these methods of attack are now coming into general use.

Of more recent methods of analysis, the electron microscope is gradually earning a recognized place. Helping to bridge the large gap between the visible microstructure and the invisible atomic structure, its high resolving power and the resultant tremendous magnifications seem to be limited only by proper sample technique, and by interpretation. Results thus far have done much to explain some of the earlier stages of metallographic changes in metals.

Another new method of attack is microradiography, wherein one may determine the changes taking place in the microstructure and also determine correlating composition changes in many alloy systems. This kind of investigation requires standards of comparison, but the availability of a metallographic tool which has the ability to determine variation in composition may well merit the ground work necessary. Experiments on welds have already shown this to be the case.

Present conditions must inevitably result to the advantage of metallography. The tremendously increased demands on metal performance have required much more profound study of the structure of metals and alloys — thus fostering the necessity for still further knowledge and the tools to aid in its accomplishment.

Name	Characteristics or Uses	Specification	Form	Composition, Per Cent						
				Cu	Si	Mn (max.)	Zn (max.)	Fe (max.)	Sn (max.)	Others
Silicon-Copper	Used for deoxidizing non-ferrous alloy melts that do not contain lead, and may be used in the making of pure copper castings	ASTM B53, Grade A	Lumps, ingots, notched slabs	Rem.	10-12	—	0.25	0.75	0.25	Al 0.25 max.
		ASTM B53, Grade B	Lumps, ingots, notched slabs	Rem.	17-21	—	0.25	0.75	0.25	Al 0.25 max.
		ASTM B53, Grade C	Lumps, ingots, notched slabs	Rem.	28-32	—	0.25	0.75	0.25	Al 0.25 max.
Copper-Silicon, Type B	This alloy is suited to hot working operations	ASTM B124, Alloy #8	Forging rods, bars and shapes	97.0 min.	0.70-1.75	0.75	1.25	0.80	2.25	Pb 0.05 max.
	For carbon arc and gas welding	—	Welding rod	97	3	—	—	—	—	—
	These lower silicon alloys have good hot working properties and are used for intricate forgings; they can also withstand severe cold working operations	ASTM B97, Type B	Sheet for general purposes	96.00 min.	0.75-2.00	0.75	1.50	0.80	1.60	Pb 0.05 max.
		ASTM B98, Type B	Rods, bars and shapes	96.00 min.	0.75-2.00	0.75	1.50	0.80	1.60	Pb 0.05 max.
		ASTM B99, Type B	Wire for general purposes	96.00 min.	0.75-2.00	0.75	1.50	0.80	1.60	Pb 0.05 max.
Copper-Silicon, Type A	This type of alloy has high tensile strength and hardness and is more difficult to cold-work as the silicon content increases	ASTM B96, Type A	Plate and sheet for pressure vessels	94.80 min.	2.75-3.50	1.50	1.50	1.60	0.75	Pb 0.05 max. Ni 0.60 max.
		ASTM B97, Type A	Sheet for general purposes	94.80 min.	2.75-3.50	1.50	1.50	1.60	0.75	Pb 0.05 max. Ni 0.60 max.
		ASTM B98, Type A	Rods, bars and shapes	94.80 min.	2.75-3.50	1.50	1.50	1.60	0.75	Pb 0.05 max.
		ASTM B99, Type A	Wire for general purposes	94.80 min.	2.75-3.50	1.50	1.50	1.60	0.75	Pb 0.05 max.
		ASTM B100, Type B	Rolled bearing and expansion plates for bridges etc.	94.80 min.	2.70-3.75	1.50	1.75	1.60	0.75	Pb 0.05 max.
		ASTM B124, Alloy #7	Forging rods, bars and shapes	94.80 min.	2.70-3.75	1.50	1.75	1.60	0.75	Pb 0.05 max.
Copper-Silicon, Type D	As is common with all copper-silicon alloys, these possess the strength of carbon steels and resist corrosion and fatigue	ASTM B98, Type D	Rods, bars and shapes	94.00 min.	2.00-3.00	1.25	4.50	0.80	1.60	Pb 0.05 max.
		ASTM B99, Type D	Wire for general purposes	94.00 min.	2.75-3.50	1.50	1.50	0.25	—	Pb 0.20-0.80
		ASTM B105	Hard drawn wire for electrical conductors	94.00 min.	3.00 max.	0.75	—	0.75	5.00	Al 3.50 max.
Copper-Silicon, Type C	Comments on Type D alloy apply here also	ASTM B96, Type C	Plate and sheet for pressure vessels	91.00 min.	2.00-3.00	1.25	4.50	0.80	—	Pb 0.05 max. Ni 0.60 max.
		ASTM B97, Type C	Sheet for general purposes	91.00 min.	2.00-3.00	1.25	4.50	0.80	—	Pb 0.05 max. Ni 0.60 max.
		ASTM B98, Type C	Rods, bars and shapes	91.00 min.	2.00-3.00	1.25	4.50	0.80	—	Pb 0.05 max.
		ASTM B99, Type C	Wire for general purposes	91.00 min.	2.00-3.00	1.25	4.50	0.80	—	Pb 0.05 max.
		ASTM B124, Alloy #9	Forging rods, bars, shapes	90.0 min.	2.30-3.75	1.50	4.25	1.60	1.50	Pb 0.05 max.
Copper-Silicon, Type G	Also as above	ASTM EA-B124	Emergency alternate specification for ASTM B124, sheet and strip	About the same analyses as the ASTM B124 alloys except that an alternate grade (fire refined) of copper is used in their manufacture						
			Sheet and strip	77	1	—	22	—	—	—

Note: *Under specifications ASTM B96, B97, B98 and B99 each type of alloy is further divided into alloy subdivisions that differ from each other by the amount of minor elements present (subject to the maxima as given above); see Appendix to each of these specifications.*

NUMBER 34 January, 1944

WHEN IT'S BRONZE
WE CAN MAKE IT

N-B-M

BRONZE

PARTS

NBM

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METALS and ALLOYS

Engineering File Facts

NUMBER 35
January. 1944

GENERAL ENGINEERING DATA

Tin Coatings

Thickness/Weight Conversion Tables

Tinplate users frequently have need for conversion tables which will give them thickness of plating in terms of weight of tin, and vice versa. Such tables are here given, with weights and measures in both English and metric units. The values are calculated using the specific gravity of tin as 7.28.

In determining the thickness of the tin plating, (1) a specimen of plate may be weighed, the tin coating dissolved off by chemical means, and the base metal weighed again, giving the weight of tin by difference; (2) the amount of tin removed may be determined chemically; or (3) the time required for removal may be matched against that for known thicknesses of coatings.

The *Base Box* (U. S.) or the *Basis Box* (British) is a unit of area equal to 31,360 sq. in. of sheet (*e.g.* 56 sheets 28 in. by 20 in. or 112 sheets 20 in. by 14 in.). The area of coated surface in a basis box is 62,720 sq. in. Coating weight on tinplates is usually expressed as *pounds per basis box* (U. S. and British) and *grams per square meter* (European continent). One gram per square meter is equivalent to 1.43 oz. avoir. per basis box.

Weight of Coating for a Given Thickness

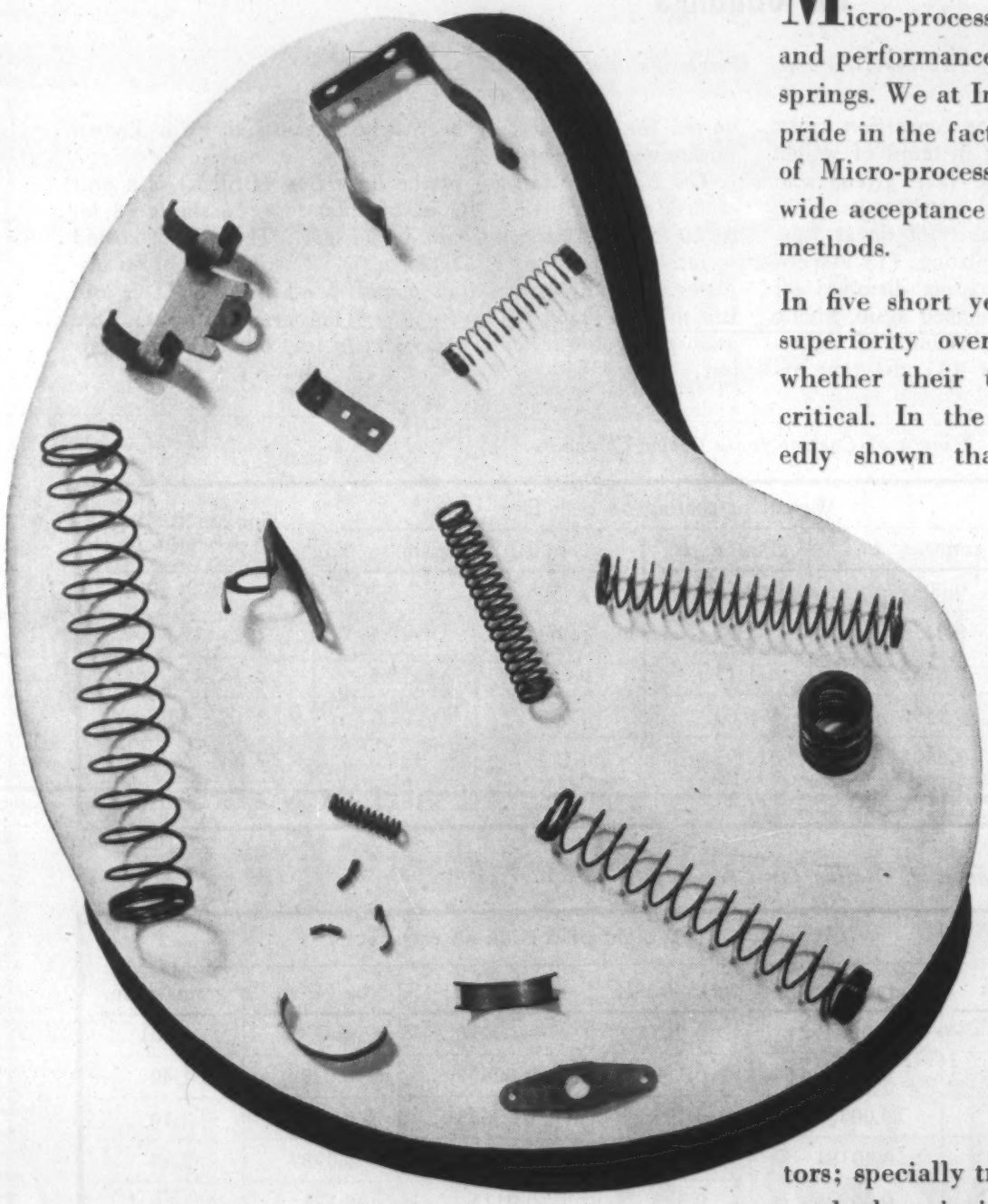
Thickness		Weight of coating on each face				Tinplate coating wt. per basis box
Inches	Millimeters	gram/sq. in.	gram/sq. ft.	oz./sq. ft.	gram/sq. m.	
0.00005	0.00127	0.00597	0.859	0.0303	9.25	13.2 oz.
0.0001	0.00254	0.0119	1.72	0.0606	18.5	1 lb. 10.4 oz.
0.0003	0.00762	0.0358	5.15	0.182	55.5	4 lb. 15.2 oz.
0.0005	0.0127	0.0597	8.69	0.303	92.5	8 lb. 4.0 oz.
0.00075	0.0191	0.0895	12.9	0.454	139	12 lb. 6.0 oz.
0.001	0.0254	0.119	17.2	0.606	185	16 lb. 8.0 oz.

Thickness of Coating for a Given Base Box Weight

oz. per box	Thickness of coating		Weight of coating on each face				
	Inches	Millimeters	gram/sq. in.	gram/sq. ft.	oz./sq. ft.	oz./sq. m.	gram/sq. m.
1	0.00000379	0.000096	0.000452	0.0651	0.00230	0.0247	0.701
2	0.00000758	0.000192	0.000904	0.130	0.00459	0.0494	1.40
3	0.0000114	0.000289	0.00136	0.195	0.00688	0.0741	2.10
4	0.0000152	0.000385	0.00181	0.260	0.00917	0.0987	2.80
5	0.0000189	0.000481	0.00226	0.325	0.0115	0.123	3.50
6	0.0000227	0.000577	0.00271	0.391	0.0138	0.149	4.20
7	0.0000265	0.000674	0.00316	0.456	0.0161	0.173	4.90
8	0.0000303	0.000770	0.00362	0.521	0.184	0.198	5.60
9	0.0000341	0.000866	0.00407	0.586	0.0207	0.223	6.31
10	0.0000379	0.000962	0.00452	0.651	0.0230	0.248	7.01
11	0.0000417	0.00106	0.00497	0.716	0.0253	0.272	7.71
12	0.0000455	0.00115	0.00542	0.781	0.0275	0.296	8.41
13	0.0000493	0.00125	0.00588	0.846	0.0298	0.321	9.11
14	0.0000530	0.00135	0.00633	0.911	0.0321	0.346	9.81
15	0.0000568	0.00144	0.00678	0.976	0.0344	0.370	10.5
16	0.0000606	0.00154	0.00723	1.04	0.0367	0.395	11.2
20	0.0000758	0.00192	0.00904	1.30	0.0459	0.494	14.0
24	0.0000909	0.00231	0.0109	1.56	0.0551	0.593	16.8

"But he that is greatest among you shall be your servant"

Matt. 23:11



"Micro-processing" sets new standards of design and performance for beryllium copper coil and flat springs. We at Instrument Specialties Company take pride in the fact that the service record of millions of Micro-processed springs has resulted in nation-wide acceptance of our unique precision production methods.

In five short years I-S springs have proved their superiority over *any* beryllium copper springs — whether their ultimate use is average or highly critical. In the same five years we have repeatedly shown that only Micro-processed beryllium copper can achieve certain desired physical and electrical characteristics. Every step in our progress is backed up in fact — on your own springs, designed and Micro-processed to meet your particular need.

How does I-S attain mass production when orders range from 1,000,000 to 10 springs with simple or complex requirements? The answer is plain to see. Special "spring grade" wire, drawn to specifications set up by the I-S production control laboratory; coiling, heat treatment and electronic micrometer inspection is directed by routine control methods based upon known factors; specially trained tool and die makers skillfully apply the principles of Micro-processing to flat spring work; and in addition, Instrument Specialties Company has in the field, resident engineers in major industrial areas who are ready to discuss with you and act upon your spring problems.

By re-defining the possibilities of spring performance we have opened new avenues for the use of beryllium copper springs — *Micro-processing, more than ever before, is a servant to the nation's industry.*

INSTRUMENT SPECIALTIES CO., INC.

DEPT. C., LITTLE FALLS, NEW JERSEY

"MICRO PROCESSED" I-S BERYLLIUM COPPER SPRINGS

FIELD ENGINEERING OFFICES: BOSTON · CHICAGO · CLEVELAND · PHILADELPHIA · NEW YORK

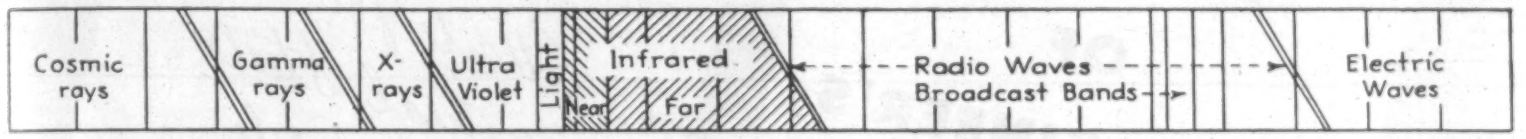
METALS and ALLOYS
Engineering File Facts

NUMBER 36
January, 1944

PROCESSES AND PROCEDURES
Finishing

Infra-Red Heating Technique

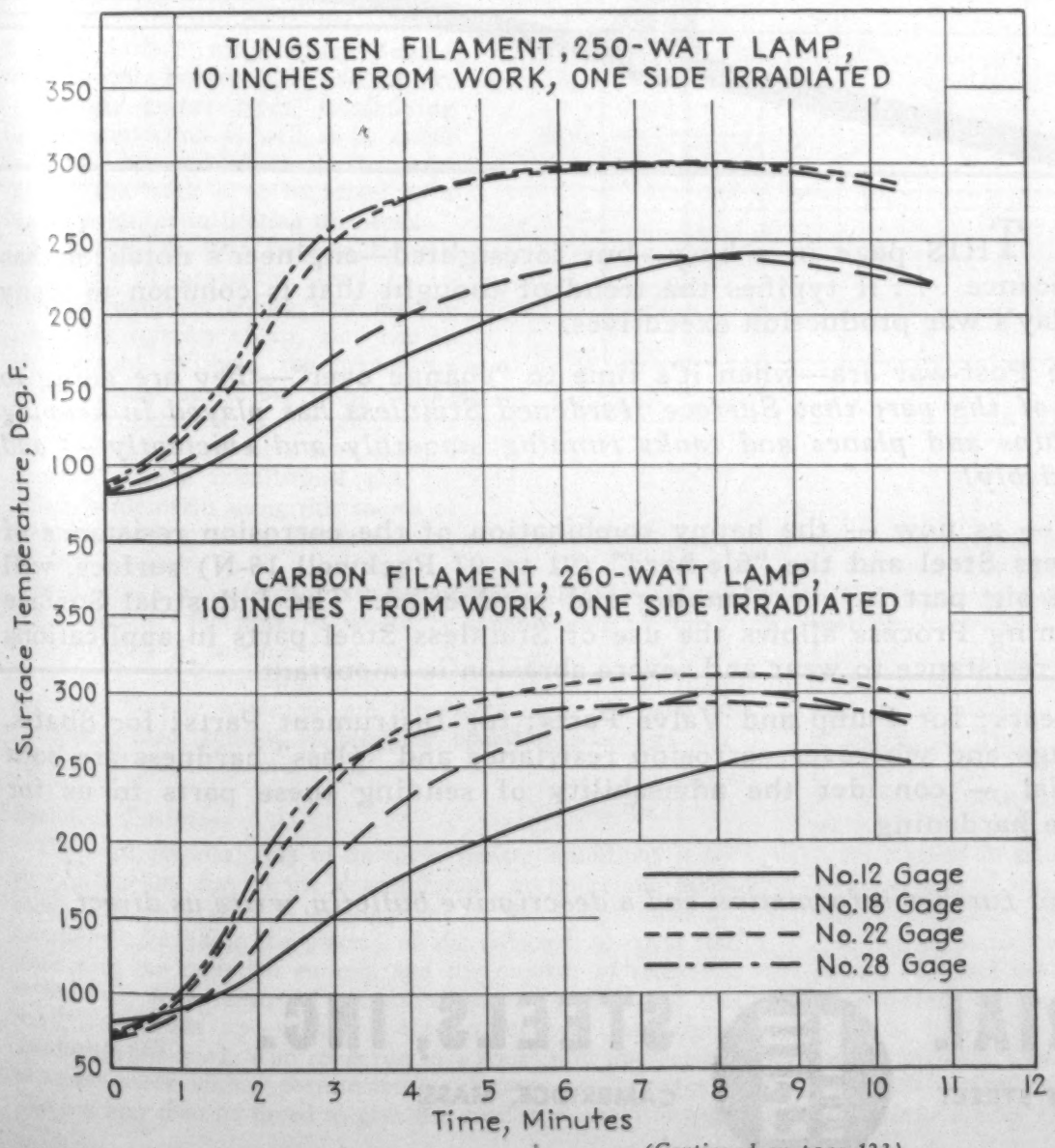
Industry has harnessed those heat rays just below the visible bands in the electromagnetic spectrum which, being of a frequency adjoining the visible red wave length, are called infra-red rays. This new heating technique is at work in the drying or baking of enamels and lacquers, skin-drying of molds in the foundry, drying of lithograph inks, dehydrating paper, fabrics, wood, etc., preheating plastics and metals, and small scale heating and melting of metals.



Infra-red radiation has been classified as "near" or "far", depending upon the place of the generated wave-lengths in the infra-red spectrum band. Its effectiveness is due to the fact that the heat is transmitted by radiation, rather than by convection or conduction, and so can be applied at higher efficiency to the surface to be heated. The surrounding air is warmed to a very slight degree by the passage of the rays.

Radiators and Reflectors

Radiant heat generators may be either electric lamps or gas burners. In both cases the amount of visible light produced is small. The lamps can be obtained in various wattages, and operate much as do ordinary lamps for electric lighting. Filaments may be of tungsten or carbon, the former operating at a few hundred degrees higher filament temperature. The gas burners are of special type, made to burn any of the commercial gaseous fuels, and these types utilize both radiation and convection for heat transfer. Both types are usually used in banks, and since infra-red radiation, like visible light, travels in a straight line, these banks may be elaborately mounted in racks to provide direct impingement on all surfaces of the work.



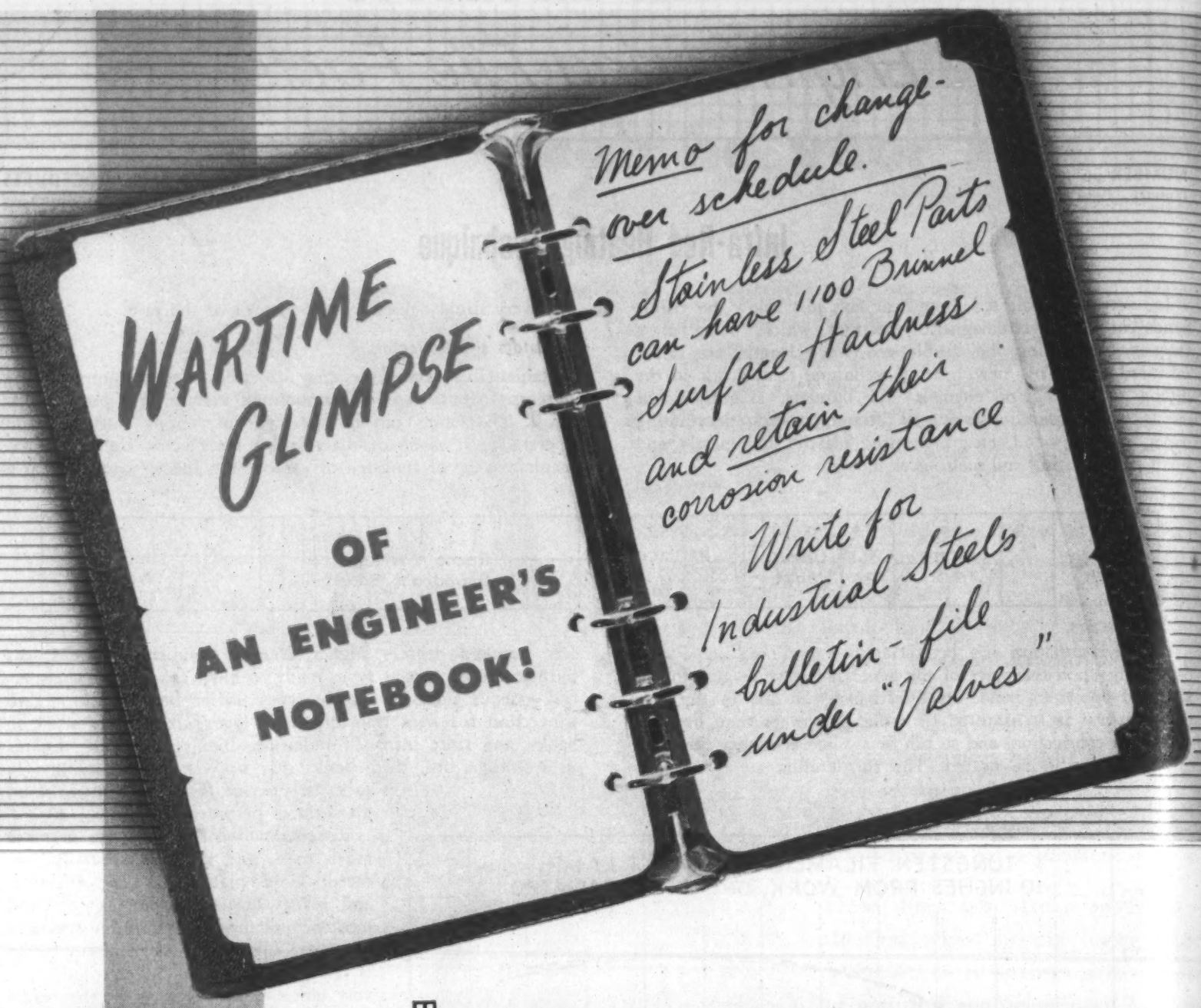
Reflectors to concentrate the rays are much used, and must be specially surfaced. Gold plating is very effective, and resists tarnishing, but is soft and must be polished with care. A specially processed high-purity aluminum plating is also much used. Silver plating is very efficient, but because of the readiness with which it tarnishes is difficult to maintain. Rhodium plating is hard and tarnish-resistant, but is very costly. Chromium is also hard, tarnish-resistant, and economical, but has a low reflectance. All of the other platings have a reflectance of more than 90%.

Applications

Radiant heating is most effective when used to heat material at a comparatively low temperature. In most applications it is desirable to avoid currents of air, since a considerable amount of the radiant heat will then be lost by convection. If highly polished metal surfaces are being heated by this method, the loss due to reflection may be substantial. Thick metal parts will heat more slowly than light-gage sheets, because of conduction losses. The heat conductivity of the material also influences conduction losses. Black or dark colors are more absorbent than white or light colors.

Factors governing the efficiency of heat transmission by radiation are the density of the material being heated, the reflectance of its surface, the projected area exposed to the rays, and the distance of the source of the radiation from the material.

(Continued on page 123)



THIS page in a busy—but foresighted—engineer's notebook has significance . . . it typifies the trend of thought that is common to many of today's war production executives.

In the Post-war era—when it's time to "change over"—*they are going to think of the part that Surface Hardened Stainless has played in keeping our ships and planes and tanks running smoothly and efficiently — and dependably!*

Then — as now — the happy combination of the corrosion resistance of Stainless Steel and the "file-hard" (91 to 97 Rockwell 15-N) surface, will play a big part in our planning and production. The Industrial Surface Hardening Process allows the use of Stainless Steel parts in applications where resistance to wear and severe abrasion is important.

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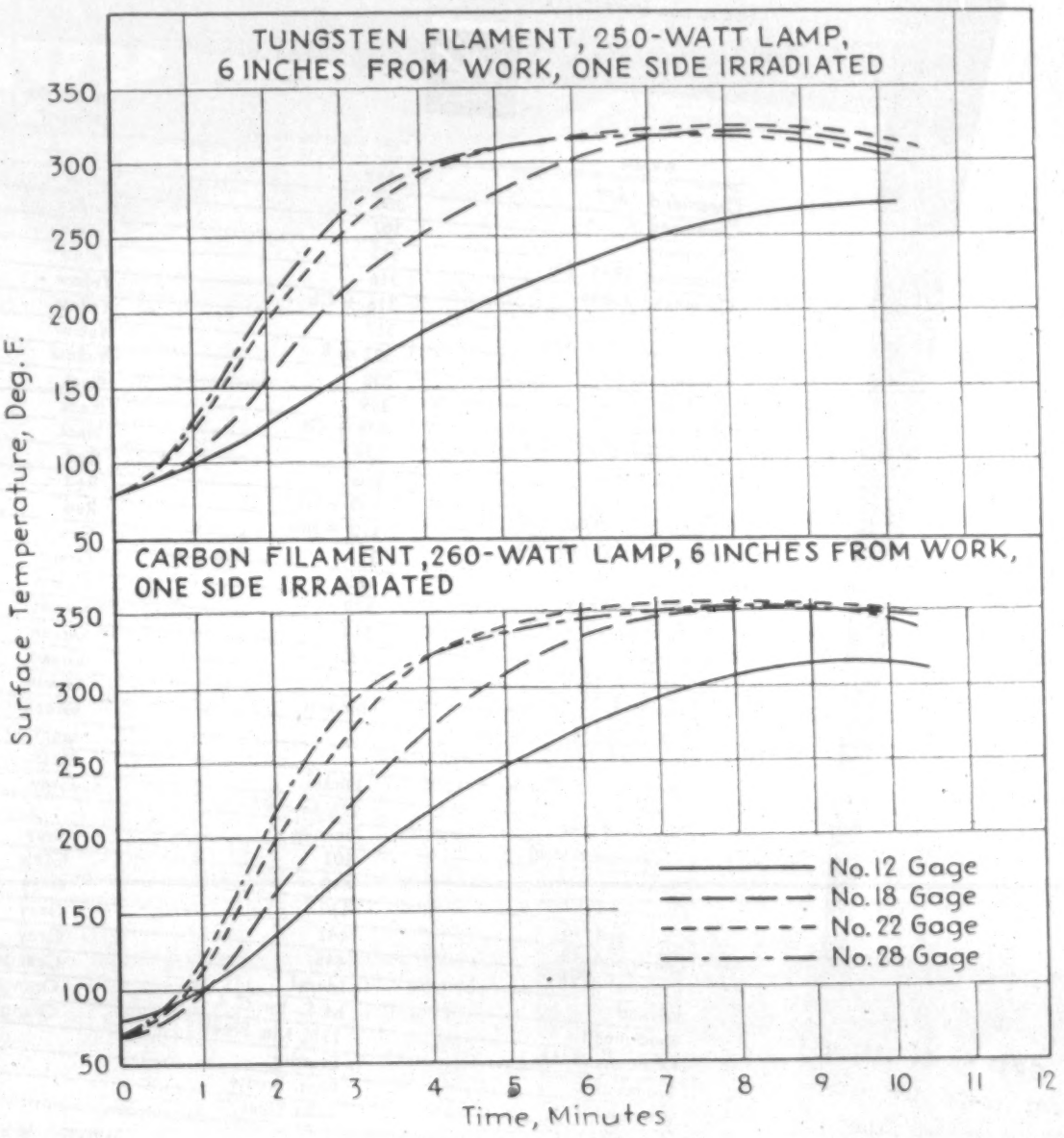
Engineering File Facts

Green sand molds have been dried efficiently, in a very small floor space in the foundry, by the use of infra-red radiation. The drying takes place to a depth of 1½ in. in an average time of about 90 min. Since no labor is required, other than placing the banks of lamps over the molds, there is a labor saving also.

In general, radiant heating is not highly efficient for uses involving evaporation, where a necessary part of the evaporative process is the removal of the vapor by convection currents. However, the process is used successfully for drying lacquer films, metal, ceramics, etc., where the amount of vapor is small. The most successful applications of this type of heating to finishes are those in which the finish is formed or converted to its final form by the heat applied. The temperature at the surface must be closely controlled, and this control is usually obtained through fixing the wattage input per square inch, or the B.t.u. per unit of surface. Surface temperatures desired are commonly between 150° and 600° F.

The gas burner types, transmitting heat by convection as well as by radiation, may be used where the temperature of the work is to be raised to a higher point, as in heating of metals.

Efficiencies of heat transfer for the lamp type of generators, used in an enclosed tunnel to reduce heat loss by convection currents of air, may rise to 65 per cent. Without the tunnel the efficiency may be of the order of 25 per cent. For the burner type, efficiencies of 65 to 85 per cent have been claimed in well-designed installations not enclosed, while ovens using this source of heat have made possible transfers rising as high as 95 per cent, the manufacturers state.



In planning an infra-red installation for drying lacquer or baking enamel, therefore, it would be desirable to set up a drying tunnel if possible. The best operating practice would be to try to place the lamp reflectors from 10 to 12 in. from the work. Surface conditions are then fixed upon the basis of the drying time required by proposed operating schedules and the type of finish desired.

Operating Conditions

The most practical way to fix these surface conditions is by an experimental run in the drying tunnel or under the lamp banks. The most efficient arrangement of the lamps must be determined, including the placing of the reflectors to cover the work with the radiation pattern, and the number of reflectors to be used. Some means of measuring the temperature of the work is then set up—usually a thermocouple or thermopile attached to the work, with leads run to a registering instrument, or marks made with a thermometric substance on its surface. The run may then be timed to give the necessary length of baking at the required temperature, or the arrangement or number of the lamps may be adjusted to give the necessary temperatures.

The temperature must be so adjusted as to give the necessary heat density without charring the finish. Heat densities may be lowered by changing the heat pattern, by moving the lamp banks farther from the material, by using lamps of lower wattage, or by placing "dummy sections" in the tunnel lamping arrangement. These sections have no lamps, but seal off the portion of the tunnel wall to prevent loss of heat from the work. Lamp wattages available range from about 80 to 1000 watts.

As a guide in estimating temperatures and times in planning an experimental run, series of test data are given in graphical form for various operating conditions.

Infra-red radiation apparatus may be turned on or off as needed, without the necessity for bringing up to an operating temperature, so that stand-by losses are eliminated. The equipment is sufficiently adaptable to permit its adjustment to a variety of uses. Operations are visible at all times. Above all, infra-red heating can usually effect substantial savings in time of baking, drying or dehydrating operations.

ARCOS ELECTRODE
STUB END IDENTIFICATION
COLOR CHART

For Arcos Electrodes manufactured after May 1, 1943

GRADE	TYPE No. (See Note)	END COLOR (Primary)	SIDE COLOR (Secondary)
Chromend 16/7	301X	Yellow	Black
Chromend K	308	Yellow	.....
Chromang	307	Black	.....
Chromend 19/9 Cb	347	Yellow	Blue
Chromend K-Mo	316	Yellow	White
Chromend K-Mo-Cb	316 + Cb	Yellow	Green
Chromend 18/8 Mo	317	Yellow	Brown
Chromend KS	302 + B	Yellow	Red
Stainlend K	308	Black	.....
Chromend HC	309	Black	White
Chromend 25/12 Cb	309 + Cb	Black	Blue
Stainlend HC	309	Red	.....
Chromend HCN	310	Red	Blue
Chromend 25/20 Cb	310 + Cb	Red	White
Chromend 25/20 Mo	310 + Mo	Green	Light Green
Chromend HN	311	Green	Brown
Chromend 8/18	325	Green	Yellow
Chromend 25/3 Mo	329	Green	Red
Chromend 29/9	312	Green	.....
Chromend 15/35	330	Green	Blue
Chromend 13/60	.....	Green	Orange
Chromend 13/75	Inconel	Green	White
Chromend 15/85	.....	Light Green	White
Chromend 20/80	.....	Black	Orange
Nickelend	Nickel	Grey	.....
Chromend 2M	2% Cr.—Mo.	.....	.....
Manganend 2M(S)	Special	Grey	Blue
Chromend 5M	502	Grey	Brown
Chromend 12	410	Grey	Green
Chromend 16	430	Grey	Red
Chromend 18	442	Grey	Yellow
Chromend 28	446	Orange	Blue
Mixend	Monel	Orange	.....
Reformend	M. S. for C. I.	Orange	Red
Manganend 13	13% Mn. Steel	.....	.....
Bronzend E	Everdur	.....	.....
Bronzend P	Phos. Bronze	.....	.....
Carend	Mild Steel	.....	.....

Note:—Type numbers are those of the American Iron and Steel Institute. The weld metal analysis nearest to that specified by A.I.S.T. is the one here used for reference.

NOTE: Where the grade name indicates analysis, the first figure is the % Chromium and the second figure is the % Nickel. (For instance, Chromend 20/80 is 20% Cr. and 80% Ni.)

A copy of this chart may be obtained from Arcos Corporation or any of their distributors listed below.

ARCOS CORPORATION 401 N. BROAD ST., PHILADELPHIA 8, PA.

Distributors Warehouse Stocks in the Following Cities:

Borger, Texas.....Hart Industrial Supply Co.
Boston, Mass. (Belmont), H. Boker & Co., Inc., W. E. Fluke
Buffalo, N.Y.....Root, Neal & Co.
Chicago, Ill.....Machinery & Welder Corp.
Cincinnati, Ohio.....Williams & Co., Inc.
Cleveland, Ohio.....Williams & Co., Inc.
Columbus, Ohio.....Williams & Co., Inc.
Detroit, Michigan....C. E. Philips & Co., Inc.
Erie, Penna.....Boyd Welding Co.
Fresno, Calif.....Victor Equipment Co.
Ft. Wayne, Ind..Wayne Welding Sup. Co., Inc.
Honolulu, Hawaii.Hawaiian Gas Products, Ltd.
Houston, Texas..Champion Rivet Co. of Texas
Kansas City, Mo..Welders Supply & Repair Co.
Kingsport, Tenn.....Slip-Not Belting Corp.
Los Angeles, Calif.....Victor Equipment Co.
Milwaukee, Wis....Machinery & Welder Corp.
Moline, Ill.....Machinery & Welder Corp.
New Orleans, La.....Wm. D. Seymour Co.
New York, N. Y.....H. Boker & Co., Inc.
Oklahoma City, Okla..Hart Industrial Supply Co.
Pampa, Texas.....Hart Industrial Supply Co.
Pittsburgh, Pa.....Williams & Co., Inc.
Rochester, N. Y.....Welding Supply Co.
San Diego, Calif.....Victor Equipment Co.
San Francisco, Calif....Victor Equipment Co.
Seattle, Wash.....Victor Equipment Co.
St. Louis, Mo.....Machinery & Welder Corp.
Syracuse, N. Y.....Welding Supply Co.
Wichita, Kansas.....Watkins, Inc.

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METALLURGICAL ENGINEERING

shop notes

Dynamiting Out Broken Drill Bits

by Nels Sorenson,
Ohio Crankshaft Co.

Dynamite is used successfully to remove broken drills from crankshafts at the Ohio Crankshaft Co., as unconventional from an engineering standard as this may sound. The breaking occurs when a workman is drilling an oil hole into the bearing surface.

Recently, 93 shafts were blown free in one month, these shafts having been valued at over $42,000. In another month 133 shafts, worth $29,000, were treated. In the case of a large diesel shaft, it took 72 charges to free the offensive drill bit, but the value of the shaft was worth all this effort.

The technique is simple, resembling blowing up tree stumps. Equipment consists of common dynamite, fuse, caps, wire probe, putty, brace and bit. The shaft is removed to a clearing outside the plant and placed on a platform, steel skid or the ground. With a wire rod the hole is probed to determine the position of the drill below the bearing surface.

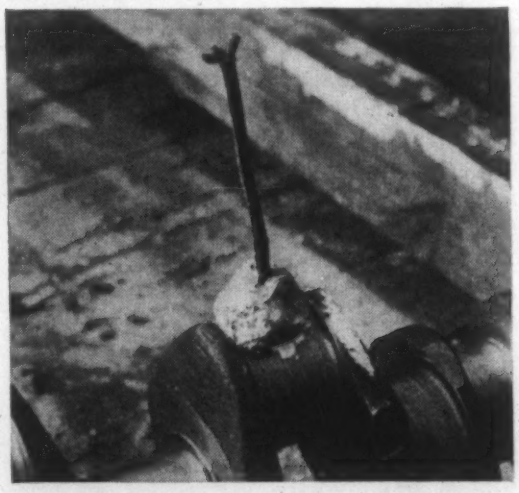
Dynamite is taken from a standard stick of blasting powder and pushed from a small trough into the hole with a round stick, no more than a thimbleful ever being used, the exact amount depending on the size of hole and set of the drill piece. The slogan is: "Put in less powder than too much."

A 6-in. fuse is next inserted into a small diameter, shoulder-free cap and dropped into the hole atop the charge. When ignited, a heavy plank or metal shield is placed over the spot to check the flight of the drill fragment as it is blown free. Often the timber splits from the dislodged drill piece; or where metal guard sheets are used, they are penetrated. It is best to keep at a safe distance after lighting the fuse.

Drills are freed by the pressure of the blast that follows the drill flutes to the bottom of the hole, there bounding back to drive the piece back out in the direction of least resistance. The operator can tell at once whether the operation has been successful by the ringing noise of metal striking metal as the drill leaves its hiding place.

Nor does this forceful ejection damage the crankshaft any more than a bullet harms a gun barrel. Immediately after blasting, the shaft is closely inspected, Magnafluxed and returned to the production line. Often an interlude of only 45 min. is required for the damaged shaft to be repaired.

Drills removed vary in size from small 3/16 in. bits to 1 1/4 in. core drills used in making lightening holes in camshafts. The big drills must be removed piece by piece with more than one shot. Here the dynamite is tamped into the oil hole



of the drill itself. To find out whether the obstructing piece is free, the operator uses a common bit and brace. If it turns easily and backs out chips, the drill has been blown free.

Where the drill has broken off flush with the crankcase surface, the operator builds a putty dam, 1½ in. high. Into the dam are inserted a fuse and dynamite cap. Either all the drill bit is blown out, or enough to allow for usual procedure without the putty.

The technique has by now been adopted by other automotive manufacturers, both in this country and in England.

In the first photo the author of this sketch watches the hole being loaded with dynamite. In the second photo a putty "dam" has been built, because the drill has broken off flush with the surface.

Automatic Tool Speeds Small Parts Production

by Karl Kunert,
Westinghouse Electric & Mfg. Co.

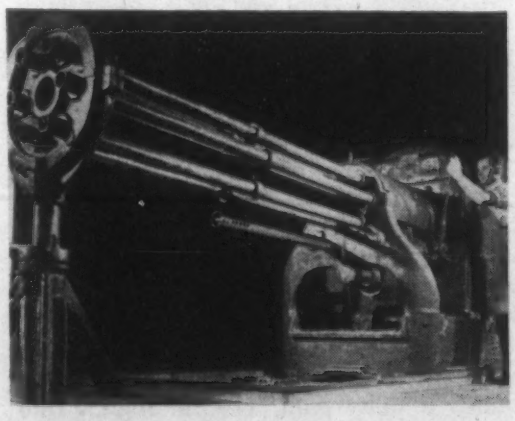
Multiple spindle automatic screw machines are increasing war production by making many of the larger parts for binoculars. For example, a single operator of an Acme Gridley machine produces 324 "objective adapters" per hr., with 13 dimensions held to close tolerance and only 1 to 2 per cent scrap.

Here are six steps in producing the part as follows:

(1) Rough forming by circular tool, and rough drilling by dual diameter drill; (2) forming by dove-tail tool, and second roughing drill; (3) finish sizing by shaving tool, plus boring and facing; (boring has three ¼-in. tool bits; two for boring, one for facing); (4) thread is rolled back of shoulder (the 1⅝ in.-36-5/32 in. wide thread is rolled over a thin wall and it is necessary to support from the inside with roller support carried on the end tool-slide); (5) recess cut by heavy-duty tool; (6) finish bore with accelerated slide and cut-off (boring bar has four ½-in. tool bits; three for boring and one for finish facing.)

Since the part is made from metal with a high zinc content, boring bars are used in steps (3) and (6) instead of reamers, such as are ordinarily used for aluminum parts. This reduces heating to help hold close tolerances, and avoids the difficulty of chips clogging the tool. In the third step, two ¼-in. tools in this bar are set at a 30 deg. angle; the facing tool is held in place with a saddle holder on the bar.

These bar-tools are easy to grind and reset; also, the first cost is considerably less than that of a reamer. By keeping the bore .0005 over the size of the thread roll support and shaving to 1.6055 for the thread roll (which is .0025 under the basic pitch diameter specified for 1⅝-36 thread), the thread is rolled to 1.623



on the outside dimension. This is within the tolerance allowed, and gives a free rolling fit on thread gage. Since holding these two dimensions accurately, it was possible in one instance to make 100,000 pieces with one thread roll.

The boring bar in the sixth step holds the three different diameters and two depths much closer than it was possible to do with a three step reamer. One diameter, 1.181 + .0007, will usually run about 3500 pieces before grinding. These tools, which cut more freely in facing than a reamer, have made it possible to easily hold the one depth 1.647 ± .001.

New Applications of Inductive Heating

by H. A. Beaudoin,
General Electric Co.

The main consideration in inductive heating is to use a frequency that is high enough to do an effective job. The motor-generator-type frequency-changer sets at frequencies from 960 to 12,000 cycles (ratings up to 1250 k.w.) have been applied to melting furnaces and to forging, upsetting, hardening, brazing and soldering.

But frequencies higher than from that equipment are needed for heating of parts of small diameter, thin sections and low-resistance materials, such as copper, brass, silver, etc. Vacuum-tube equipment lends itself to most economical use at frequencies above 150,000 cycles. The vacuum-tube oscillator supplements, but does not replace, the motor-generator-type frequency-changer.

Vacuum-tube power oscillators with an output frequency of 500,000 cycles have been built in recent years. These electronic heaters use the simplest possible circuit, are reliable, low in cost and easy of operation by unskilled personnel.

Innumerable applications are possible. In the manufacture of Calrod heating units, bushings and terminals were formerly torch-brazed. Since the terminals brazed on the ends of the Calrod units contain a mycalex insert, heat must be controlled carefully to avoid cracking or melting the mycalex. Electronic heaters produce a more uniform joint and speed up operations.

In the making of radio equipment crystals, these are mounted in a holder and enclosed in a shell resembling the small metal radio tube. The shell was formerly flame-soldered to the base, but heat would occasionally crack the crystal and products of combustion would affect the crystal's performance. Now, six inductor coils (in series) permit simultaneous inductive heating for soldering six crystals with heat entirely confined to the rim. Heat is applied for 3 sec. and a cooling air blast for 10 sec.

Many electric devices require an air-tight insulating bushing for electrical connections, typical being where conductor and metal flange are cast in a glass insulator. The electronic heater brazes the copper stud to the alloy cup and simultaneously fuses a glass coating on the rim, thus assuring a tight joint when cast in place in the glass insulator.

There's the case of a small shaft ¼-in. in diam. and 1¼ in. long. The problem was to harden the middle bearing surface, yet leave the ends unaffected. This part is heated to hardening temperature under water. As the part within the inductor coil heats up, a film of steam forms around the heated area, protecting it from cooling action of the water. When power is removed after 3½ sec. the vapor envelope immediately collapses, permitting the water to rapidly quench the part. Approximately 4 k.w. output at 500,000 cycles was used.

Among other small parts being inductively heated for surface hardening are small gears, small spline shafts, cams and small areas of larger pieces.

Some G.E. electronic heaters provide better fabrication methods, allow for the saving of critical materials, and make possible the use of unskilled workers.

Because of an intensive educational campaign in one section of the country, the following technique for salvaging welding rods has been developed: The work is usually delegated to a beginner welder. Several stubs are laid on a metal plate, with ends projecting. The welder places a stub in the welding tool and, by contact, welds the short pieces progressively to build up a usable length.

—"War Production News," War Production Board

Sketches to Aid Welders

by Georgena Brannon,
Cessna Aircraft Co.

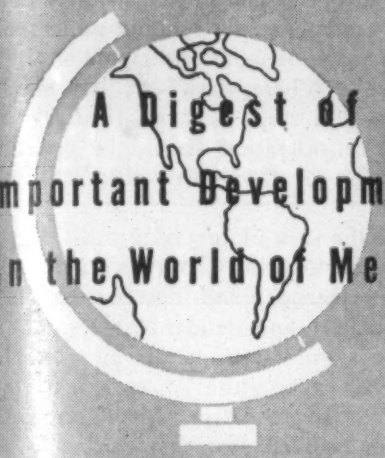
Formerly, when a standard complex assembly for aircraft, such as rudder assembly or pilot's seat, was to be welded in mass production the most experienced welder in the shop made up as many finished assemblies to be used as models, as there were inexperienced welders. But this took valuable time and tied up materials.

I was assigned to make penciled or paint sketches of these assemblies, one copy going to each operator. It is a perspective drawing of the piece as it would appear to the workman, carefully indicating the direction of each weld. Added to each sketch is a simply-worded outline of procedure which enables the operator to follow the same methods a more experienced man would choose from his years of training.

First, several skilled operators put their heads together to determine the best way to fabricate the assembly. Then the actual work is done to turn out a model assembly, from which the sketches are drawn.

Sketches of this assembled tubing or other materials have proved as effective as the genuine article and they can be rapidly produced in quantity. The system has proved so successful that it is being considered for departments of the plant outside the welding shops.

Metallurgical Engineering Digest



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Rolling Mill Power Consumption

Condensed from "Blast Furnace and Steel Plant"

The losses involved in making available mechanical power at the roll face can be roughly classified as follows:

(1) Mechanical losses—
  (a) Roll neck, mill and drive friction;
  (b) Power consumed in starting, acceleration, reversal, deceleration, and stopping.

(2) Electrical losses.

The major part of the friction loss is that sustained at the roll necks. Up to 90% of the total energy input to the mill may be lost in friction losses. Where the mill is allowed to run continuously (which often happens), the rate of rolling has a decided influence on the percentage of friction loss.

Excessive numbers of passes, slow handling between passes, delays, etc. result in relatively high frictional consumption. Where, however, the motor drive is shut down during long delays, the power consumption will not vary greatly with different tonnage rates for the same combination of beginning and end products.

The type of bearings in use can have an important effect on power consumption. In one case, using ordinary bearings in rolling ingots down to 4-in. billets, the consumption was 24 kw-hr. per ton. When a mill becomes out of alignment, friction losses are greatly increased—in one case the increase was 30%.

Energy Necessary to Start a Mill

The energy required to start a mill and its drive is comprised of:

(1) That required to overcome static friction.

(2) The stored energy at rolling speed.

The torque exerted in respect of the former is known as the starting torque and that in respect of the latter, the accelerating torque. The power required for starting a continuously running mill usually appears as an insignificant ripple on the power curve. Where, however, the number of starts and stops becomes relatively numerous, consideration should be given to the question of the power absorbed in doing this.

In the case of reversing mills, the power required to bring about successive acceleration, reversals, and decelerations is quite substantial, and standards in respect of such mills should include an allowance for a normal expenditure of energy in this respect. In a 44-in. blooming mill the power required for this work was 34.5% of the total.

Magnetizing current loss occurs only in a.c. apparatus. This item does not appear in statements of efficiency and losses based on readings of true power, but where total kva. are accounted for, this loss will be identified and the total loss is represented by the number of reactive kva.

Losses due to "grounds" always occur through leakage of current. The definition of a ground has been given as "the failure of insulation between parts not normally carrying current and conductors." This differentiates it from a "short circuit."

Standards of Power Consumption

With regard to the establishment of standards of power consumption, it will be assumed that standard consumptions are adopted per unit weight of product for each combination of ingot, bloom, billet, etc., and that such consumptions represent what power should be used under conditions of reasonable operating efficiency.

Thus, it is only necessary to extend out the tonnage of any section or bar, etc. rolled at the standard rate for that particular operation to obtain the standard cost. Standard and actual consumptions could be the overall figures for all the equipment involved, and if this is done, they may aggregate the consumptions of quite a number of main motors and many and varied motors employed in the ancillary processes.

In some cases the intermittent character of the operation results in relatively heavy power consumption in order to carry out repeated cycles of acceleration, reversal and deceleration. This feature has already been commented on in respect to reversing mill main motors, but a similar state of affairs exists in relation to many auxiliary motors.

A standard pass specification should be adopted as different shifts tend to have different practices. In one case, one shift

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TRADE MARK REG. U. S. PAT. OFF.

DUSTLESS DENSE
SODA ASH No. 2-10

...IT'S GRANULAR!

A new form of SOLVAY Dustless Dense SODA ASH created especially for desulfurization is now available.

Designated as No. 2-10, this product has been made granular to further facilitate handling.

Immediate delivery of No. 2-10 can be made. Inquiries are invited.

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NOTE

*"Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.

●

Send for booklet
"INGOT METALS OF TODAY"

●

16 STANDARD INGOT METALS BY AJAX

Ajax Tombasil
Ajax Plastic Bronze
Ajax Anti-Acid Bronze
Ajax Phosphor Bronze
Ajax Red Brass Ingots
Ajax Manganese Bronze
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Ajax Golden Glow Yellow Brass
Ajax-Hamilton Gear Bronze
Ajax Nickel-Copper 50-50%
Ajax Manganese Copper
Ajax Aluminum Alloys
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Ajax Nickel Alloys
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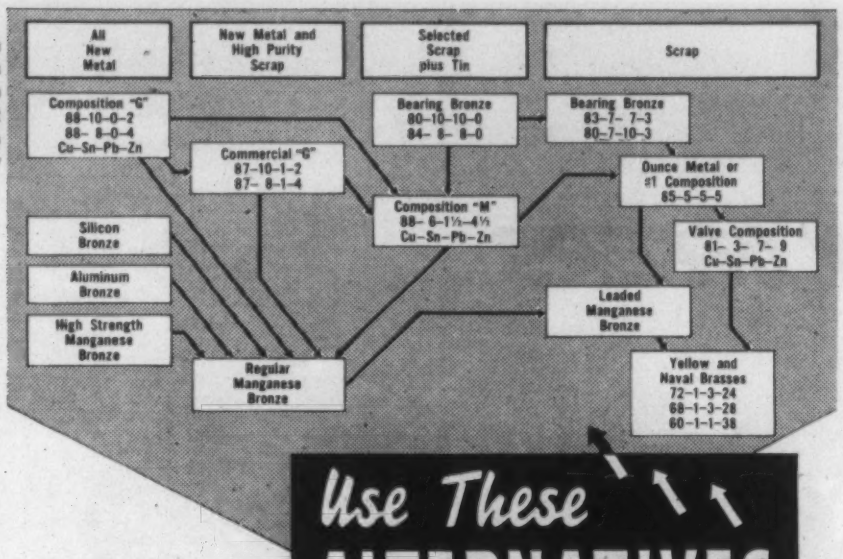

Use These ALTERNATIVES Wherever You Can

Notice how the arrows on the W.P.B. chart point to the *right*. . . . They show how alternative materials *currently available* can be utilized by foundrymen as now permitted by many designers. The purpose is to conserve primary metal at the mine through increased use of secondary ingots. Sometimes great ingenuity is called for, yet remember this:
The first program for scientific control of ingot metal was set up by Ajax 46 years ago. The result has been metal and practical technical follow-through in which Ajax increases your production by reducing rejects.

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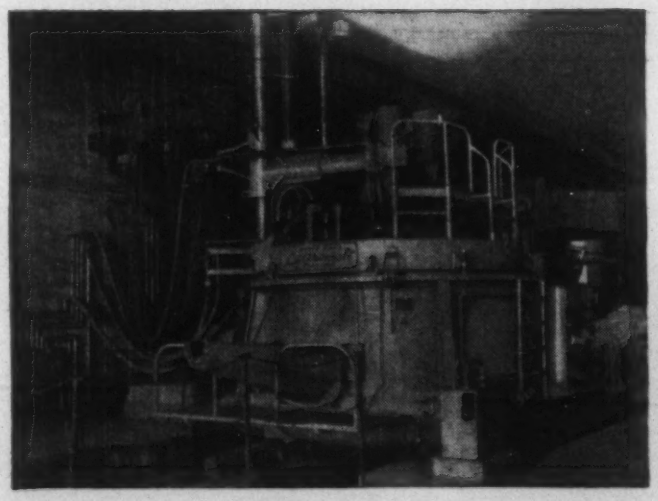
the furnace of today and tomorrow



ARMY E NAVY

MOORE RAPID Lectromelt FURNACES

★ Flexibility, rapidity and economy of operation are distinguishing features of LECTROMELT furnaces. They are ruggedly built to give long and efficient service with minimum maintenance. Top charge type LECTROMELTS increase steel production with less consumption of power, and with savings in refractory and electrode costs. Both door charge and top charge LECTROMELTS are available in sizes ranging from 100 tons down to 25 pounds capacity. Write for complete details.

PITTSBURGH LECTROMELT FURNACE CORPORATION
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used 21 passes and another one 23—in the latter case the increase in rolling time was 7.8% and the increase in manipulating time 10%.

In regard to the effect of the skill of the workers, the rolling time per ingot in one instance was 2½ min., whereas the time taken should have been 2 min. Inefficient operation by one of the pulpit men was responsible for the delay.

New rolls can cause an increase in rolling time due to the extra difficulty in gripping the ingot. In one series of tests this amounted to an increase of 10 to 65%.

Efficient Time Studies

The computation of really satisfactory standards should be preceded by efficient time studies, the objects of which have been stated to be:

(1) To determine the maximum outputs of various classes of products.

(2) To investigate the possibilities of increasing output and reducing costs.

(3) To use the data as a basis in connection with a piecework system.

(4) To use the data as a basis for a costing system.

The standards will, or should, reflect the actual conditions obtained while the products concerned were being rolled.

The stands of rolling mills may be disposed in the following manner: (1) All stands arranged in line or "in trains" along a common axis; (2) stands as in (1) may be split up into smaller groups of stands, the axes of the groups being parallel or slightly inclined to one another; (3) stands arranged in tandem with stock passing in a straight line through each in succession; and (4) some combination of the foregoing.

The mill drive may consist of anything between a single large motor and individual motors for each stand. Certain billet, bar and rod mills producing only a few specialized products are provided with group drive by either constant speed synchronous or induction motors. Other mills produce a wide range of products involving considerable differences in shapes, sizes and qualities.

Sometimes a mill operates on wide varieties of schedules, and some of these schedules may require the operation of only part of the mill motors or the motors may be only partially loaded so that only part of the generating capacity is required.

—F. Ryder. *Blast Furnace & Steel Plant*, Vol. 31, Sept. 1943, pp. 1030-1035; Oct. pp. 1152-1154.

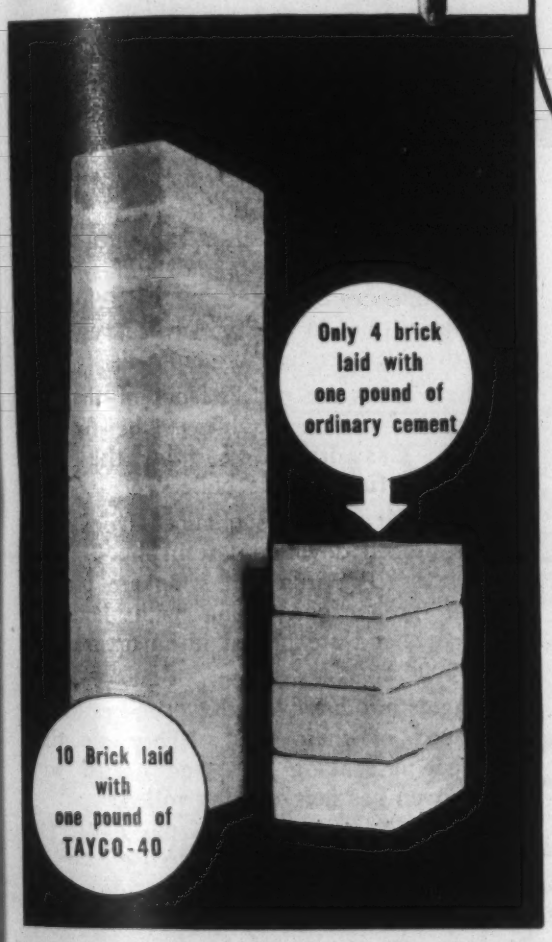
Blast Furnace Gas Provides Power

Condensed from "American Gas Journal"

The new Kaiser Company steel plant at Fontana, Calif., consists of a blast furnace producing 1200 tons of pig iron every 24 hrs.; four open-hearth furnaces with a capacity of 450,000 tons of steel ingots; and a plate mill, capacity 300,000 tons of ship plate per year.

The steam plant has three Babcock & Wilcox furnace boilers. One burns oil, while the other two are designed to burn

"LOOK HERE! THIS IS WHY TAYCO-40 CEMENT MAKES MY JOB EASIER!"



TAYCO-40 Cement is popular with brick masonry superintendents in Steel and Glass Plants throughout the United States and Canada. As one boss brick mason put it — "Tayco-40 Cement makes my job easier, as I know my men will lay silica brick and shapes with uniformly thin joints . . . they cannot avoid doing a good job."

WORKING PROPERTIES— Easy-to-use TAYCO-40, unlike other silica cements or mortars, will retain water and remain plastic for several minutes when applied to porous silica refractories, allowing ample time for proper laying and fitting of arches, jambs, electric furnace roofs, walls, etc.

SOFTENING POINT— Almost equal to that of the best grades of silica brick. It contains no clay or sodium silicate.

ECONOMY— Due to its remarkable smooth working and water retention properties, less cement is used; thinner, tighter joints are obtained; and losses in mixing and handling are materially reduced.

Write for prices and your copy of Bulletin 505

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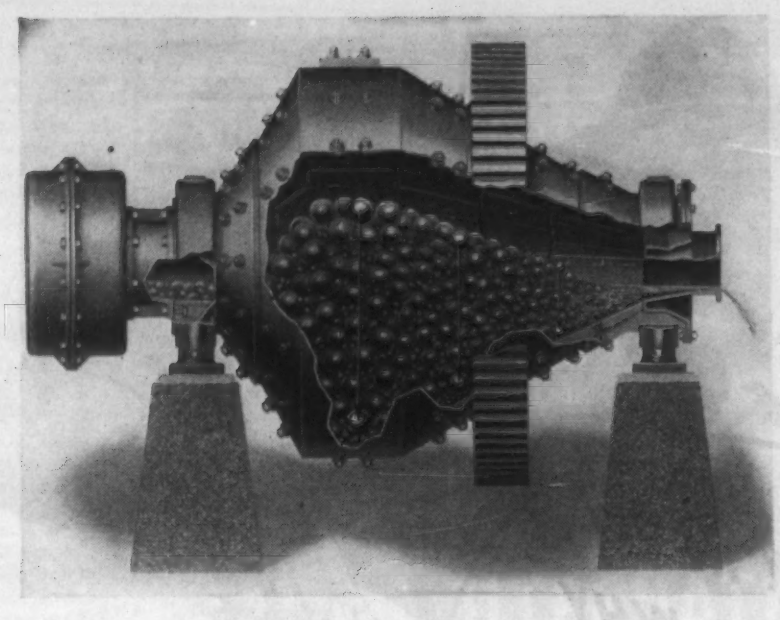

Conical Ball Mills for Metal Reclamation

Treating

Metal Scrap — Slag — Dross Skimmings and Floor Sweepings.

The conical shape of the mill classifies the balls and material according to size.

No grates or other obstructions to hinder the passage of the material thru the mill.

Overgrinding of the metal is prevented by the classifying action and the rapid passage of the material thru the mill.

A uniform size of product with a minimum loss of fine metal.

Write for Bulletin 8-A.

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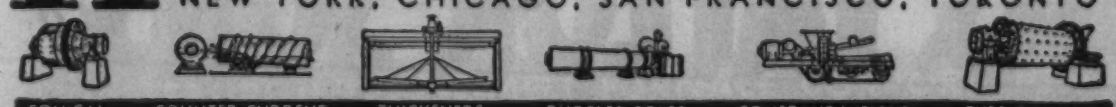

CONICAL MILLS | COUNTER CURRENT CLASSIFIERS | THICKENERS CLARIFIERS | RUGGLES-COLES DRYERS | CONSTANT WEIGHT FEEDERS | TUBE ROD AND BATCH MILLS

coke-oven and blast furnace gas. The blast furnace is in the form of a 1-in. thick steel shell 130 ft. in circumference, 97 ft. high. It is expected to produce 432,000 tons of pig iron annually.

A charge of limestone, coke and ore is fused in a hot blast at 2700° F. Three side combustion stoves are set up adjacent to the blast furnace. Turbo-blowers deliver air to the stoves at the rate of 85,000 to 100,000 cu. ft. per min., and in the stoves it is heated to 2700° F.

The gas washer has a capacity of 110,000 cu. ft. per min., is 35 ft. high, and has an inside diameter of 20 ft. Gas enters at the bottom of the washer and passes through five tiers of tile, contacting water from the spray nozzles on the upward journey.

From the washer, the gas passes through Cottrell precipitators for final removal of impurities. It is then piped to a storage holder.

The 90 coke ovens are arranged in batteries of 45 each. Under full operation, 1728 tons of coal produces 933 net tons of coke.

When gas from the blast furnace is used for firing, one generator takes gas and the other air, so that both are preheated and both unite at the base of the flue. The flues operate at about 2350° F. for carbonizing coke in 18 hrs., which results in an oven temperature of 2100° F.

Raw gases are distilled out of the coal, leaving a carbon residue in the form of coke. Gas drawn off from the ovens serves as fuel for the boilers.

Coal for coking is obtained from Utah. It is broken down to 1¾ in. by Bradford breakers. Pig iron and scrap are used in equal proportions, along with limestone and ore, and are heated in an open-hearth to 3000° F.

Ingots produced in the open-hearth are stripped of their crust. They are then placed in soaking pits, and heated with coke-oven gas before being rolled.

—Fred A. Herr. *Am. Gas J.* Vol. 159, Sept. 1943, pp. 11-13, 38.

New Aluminum Reduction Plant

Condensed from "Western Metals"

San Francisco's Hetch Hetchy power system will furnish 100,000 kw. of power for the new aluminum reduction plant at Riverbank, Calif., which produces large quantities of the metal for the war effort. The plant constitutes the last stage in this production of the light metal before fabrication into various shapes for airplanes and other equipment.

Alumina, the product of the Bayer process at other plants, is shipped to this plant and the Hall process is used to reduce this to metallic aluminum. In this process the pots in which the reduction is made are connected in series on 650-volt circuits, each pot line including about 100 pots.

The Riverbank plant will have 3 pot lines with rectifiers to convert alternating to di-

Old Dog Tray is ever faithful

TUNGSTEN ——

has proved its worth

The standard material for many years, throughout a well defined range of uses, has been tungsten high-speed steel — dependable, uniform in behavior, little subject to scaling or distortion under heat treatment, marvellous for its contribution to the needful qualities of modern machine tools. It might have seemed that such a material, if it became scarce in wartime, would leave a fatal gap.

Tungsten has been scarce for many months. But so great has been the resourcefulness of our metallurgy and so fortunate our access to Molybdenum and other alternative materials, that American war production has gone on at a mighty pace.

Molybdenum high-speed steel, so called, did much to take the place of the familiar "18-4-1" tungsten-steel. Yet it did require some Tungsten, and it did necessitate changes in heat treating — often changes in furnace equipment.

With Tungsten again obtainable in increasing amounts, naturally some users are returning to their favorite of other days. Manufacturers of tool steels will gladly supply them.

Inquiries concerning any use of Tungsten, Boron, or Molybdenum will be welcomed by the Molybdenum Corporation.

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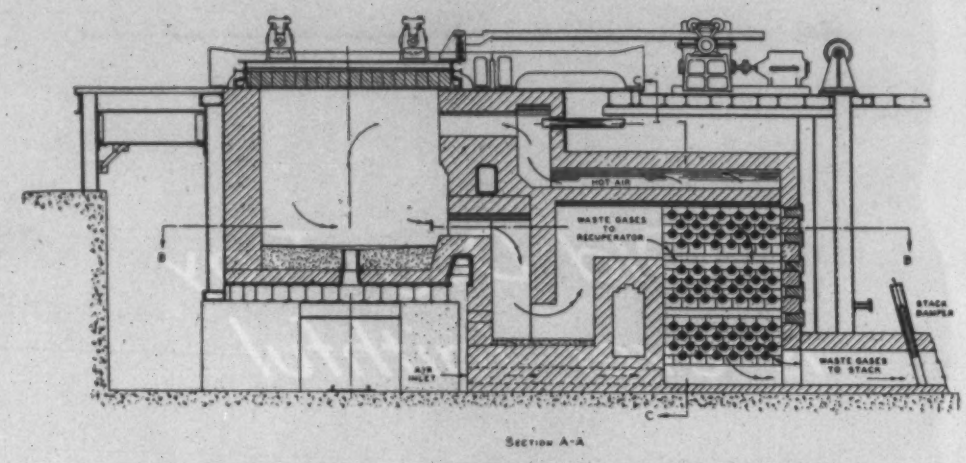
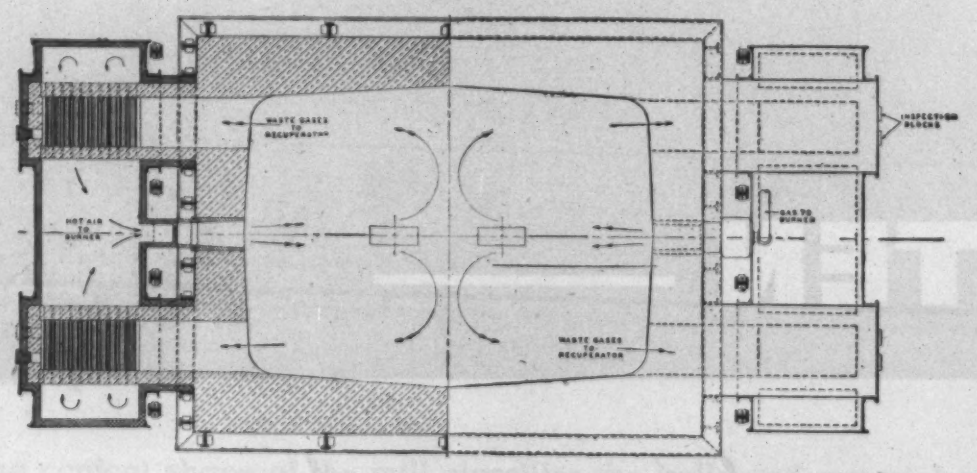


SECTION A-A

A single hole equipped with one recuperator.



A single hole equipped with four recuperators.

To date there are over 170 pits of various designs equipped with "Fitch" Recuperators. Many of these pits have replaced the regenerative type previously used, resulting in a greatly increased tonnage of steel heated.

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Write for Bulletin No. 12

"FITCH" RECUPERATORS for the STEEL INDUSTRY

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rect current, transformers to step down the voltage from 110,000 volts, and the necessary switching equipment and accessories.

The first pot line went into productive operation May 15, 1943, and uses 36,000 kw. of power, including that for station service. The second pot line was scheduled to start producing about Sept. 15, and the third about Oct. 15, by which time the total demand of 100,000 kw. will be reached.

The estimated cost of construction of the plant, taking up a square mile of land, is $12,000,000. Built by the Defense Plant Corp., the Aluminum Co. of America is operating it under lease. About 600 employees will be needed for its operation. A housing project, nearing completion, will accommodate Riverbank's new population.

To house the 21 rectifiers and switchboard, a building 648 ft. long is necessary. Each of the 3 pot lines requires two 743-ft. buildings. The rodding building, for reconstructing electrodes used up in service, is also 743 ft. long. The shipping building is 643 ft. long. There is a fully equipped laboratory building and a capacious machine shop, as well as a separate administration building.

Huge tanks will store the alumina that will arrive in trainloads 4 or 5 days apart, and carbon for electrodes will also come in trainloads. To conserve copper, the large bus bars between the rectifiers and the pots are made of silver, loaned by the Government and appropriately guarded.

The annual production of metal at this Riverdale plant is expected to exceed 80,000,000 lbs. (40,000 tons) of aluminum. It takes 4 lbs. of bauxite to make 2 lbs. of alumina, from which 1 lb. of aluminum is finally produced.

—*Western Metals*, Vol. 1, Oct. 1943, p. 24.

Welded Blast Furnace

Condensed from "Steel"

Arc welding in the place of riveting has been adopted by the steel industry in blast furnace construction, being applied to the fabrication of steel plate in the furnace shell, mantle, tuyeres breast jacket, dust catcher, whirler, hot blast stoves, gas and air piping and walkaways.

One of the first furnaces built by the newer processes was the No. 3 at the Weirton Steel Co., Weirton, Va., which was blown in December, 1941. The first welded furnace started pouring 8 months after start of construction as against 12 months under conventional construction.

In the welding of the furnace shell a shrinkage of 1/8 in. at each joint in the plates was anticipated, they being erected with a 1/8 in. gap between the edges. The joints were so welded in sequence as to reduce a tendency to distort the structure due to shrinkage of the joints. When completed, a plumb line dropped from the center of the top casting to the bottom of the furnace indicated no measurable out-of-

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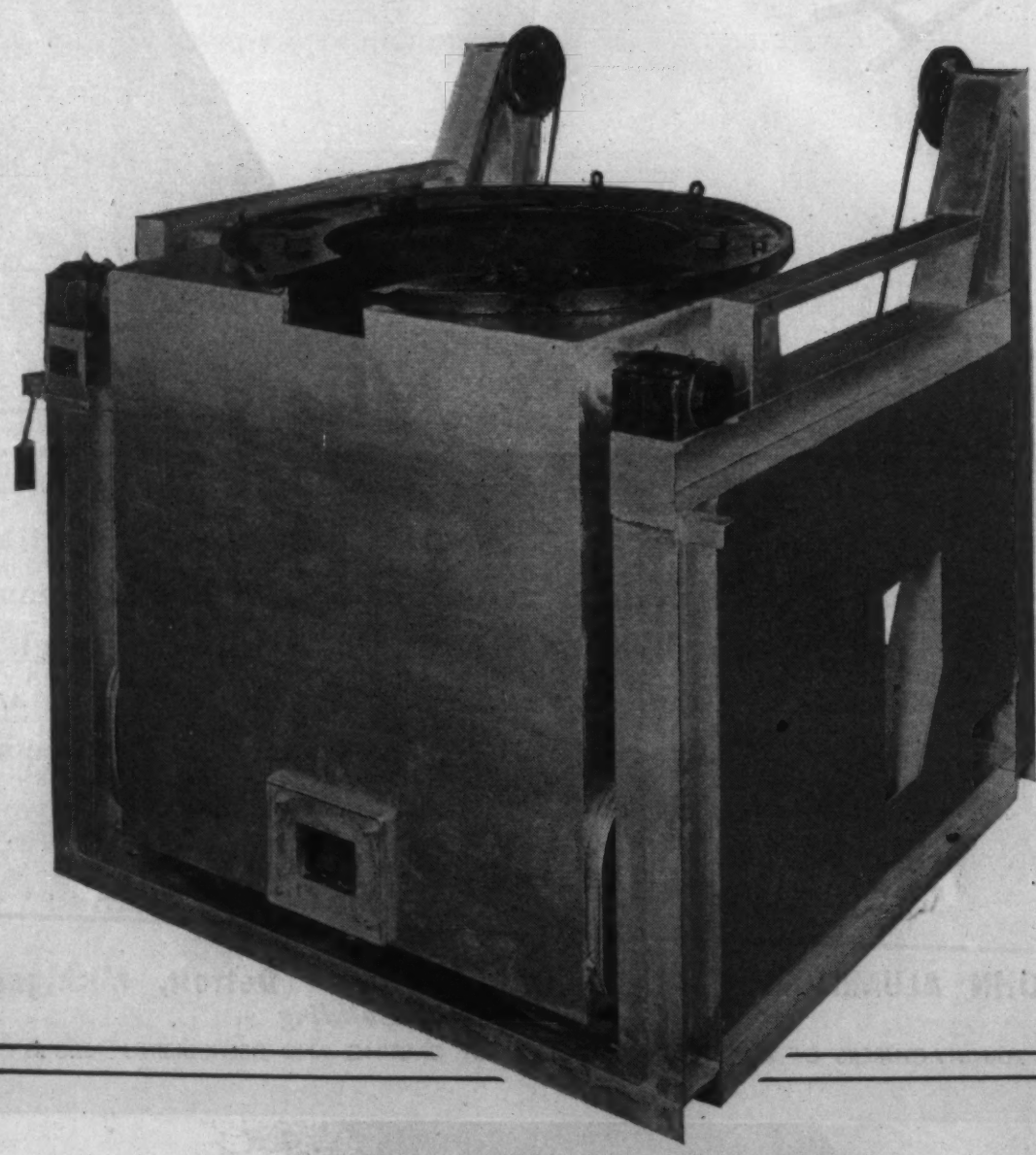


THE MONARCH ENGINEERING AND MANUFACTURING CO.

Curtis Bay Baltimore, Md.

alignment from the center of the furnace at the bottom. Measurements to determine the actual elevation at the top of the flange of the casting indicated a difference of only 1/16 in. from the previously figured elevation.

As to the dust catcher, some interesting design features of this welded structure are: smooth inside surfaces of the butt-welded plates, reducing abrasion of the plates by particles of the dust-laden gas; simplicity of the column connecting to the shell; connection of the top and bottom cone sections to the shell, using a buttwelded joint where previous designs would require expensive flanging of these plates to make a lap joint; the compression ring of the belt seam, consisting of an angle and bar; the simple welded detail transmitting the equivalent of this section around the column connection and the plain portal bracing in two panels of the tower.

Again in the whirler, it would have been much more expensive to provide a smooth, continuous, abrasion-resistant surface by any other method than welding. The stoves are entirely buttwelded, using 5/8 and 3/4 in. plates. The numerous nozzles were also welded. This construction facilitated the laying of the brickwork adjacent to the smooth inner surfaces. It also assured a gas-tight connection.

As to the exhaust stacks, the shops were glutted with other work. Accordingly, the shop only prepared the edges and rolled the plates. On the location the field crew welded the plates into sections and the costs showed no appreciable loss of efficiency, thus showing the adaptability of welded pipe designs.

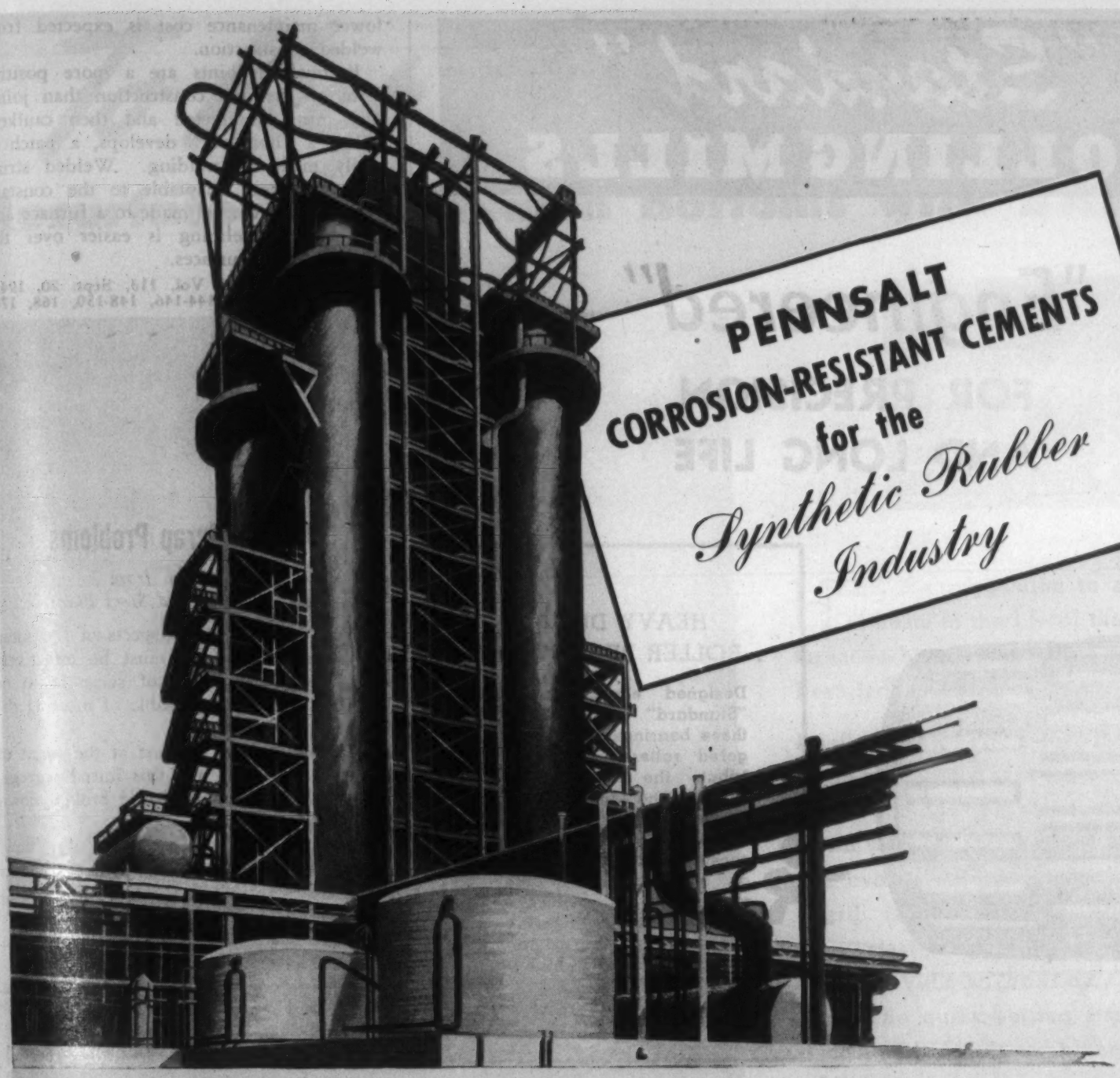
Savings in Weight

On the furnace shells the heavy butt straps or plate laps are eliminated, and in accessory structures there are weight savings also. Generally less steel is used in the first place, so there are less freight charges from the fabrication plant to location. In the drafting department, preparation and checking of detailed drawings are simplified by arc-welding. Buttwelded joints simplify drafting so that time required is reduced almost by one-half.

For the furnace shells and, perhaps, other accessories, the riveted job must be completely erected and then dismantled to assure a proper fit in the field, all of which is not required in a welding job. There is also a reduction in the number of pieces in welding design, particularly in the mantle. The overhead of a weldery is lower than for a riveting shop, the machinery is smaller and less expensive, there are fewer tools, fewer operations and supervisory workmen.

All openings for pipes are burned at their proper locations, these being determined only after the structures have been erected and welded, thus assuring an accurate alignment.

There are other savings, such as social security taxes and insurance. Total savings by welding on a modern blast furnace may be estimated at $154,000. Multiply by the 15 new furnaces on the present blast furnace program and you get $2,310,000. Moreover, as experience in welding furnaces grows, costs will decrease. Also a



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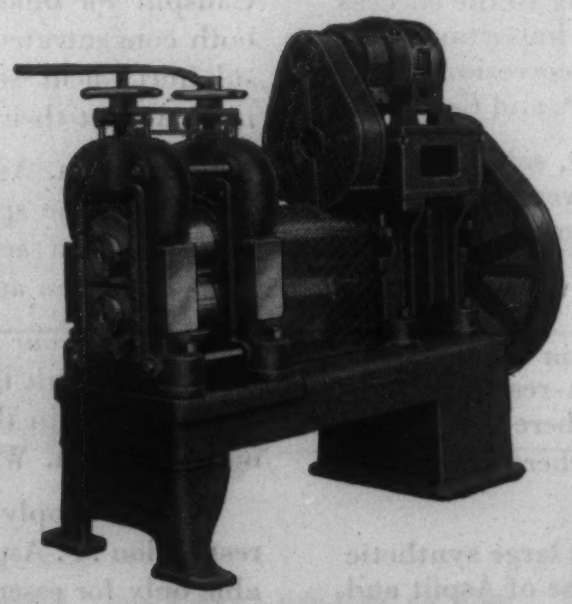

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STANDARD MACHINERY CO.
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lower maintenance cost is expected from welded construction.

Buttwelded joints are a more positive form of gas-tight construction than joints that must be riveted and then caulked. When a "hot spot" develops, a patch is easily made by welding. Welded structures are more adaptable to the constant minor improvements made to a furnace and its design. Relining is easier over the smooth inside surfaces.

—R. F. Fey, *Steel*, Vol. 113, Sept. 20, 1943, pp. 144-146, 148-150, 168, 170.

Wartime Scrap Problems

Condensed from "Blast Furnace and Steel Plant"

There are two main aspects of the scrap problem that can and must be effectively dealt with if the flow of scrap is to be maintained at a rate capable of meeting the demand. They are:

(1) Sorting has to start at the plant of the steel consumer, and this initial segregation must be maintained and broken down further by dealers.

(2) Any interruption to the flow, whether it arises from failure of consumers to purchase, failure of appropriate agencies to collect, or failure of the scrap producers to make it consistently available, has a profound effect on the entire pattern.

Currently, dealers are believed to have labor enough to handle their part of the program. The War Manpower Commission has announced that the scrap metal industry is an essential war activity and that certain employees are eligible for deferment.

No. 1 heavy melting steel is practically non-existent. Consequently, it continues to be necessary for consumers to maintain production with lighter and less desirable grades of scrap. Much has been accomplished in this direction. There is still a useful function, however, for more preparation equipment.

It is estimated that alloy turnings are appearing at the rate of 200,000 gross tons per month and carbon turnings at about 400,000 tons per month. This volume is reported to be moving, but no general estimate of the extent of actual use nor the manner in which it is being used is available.

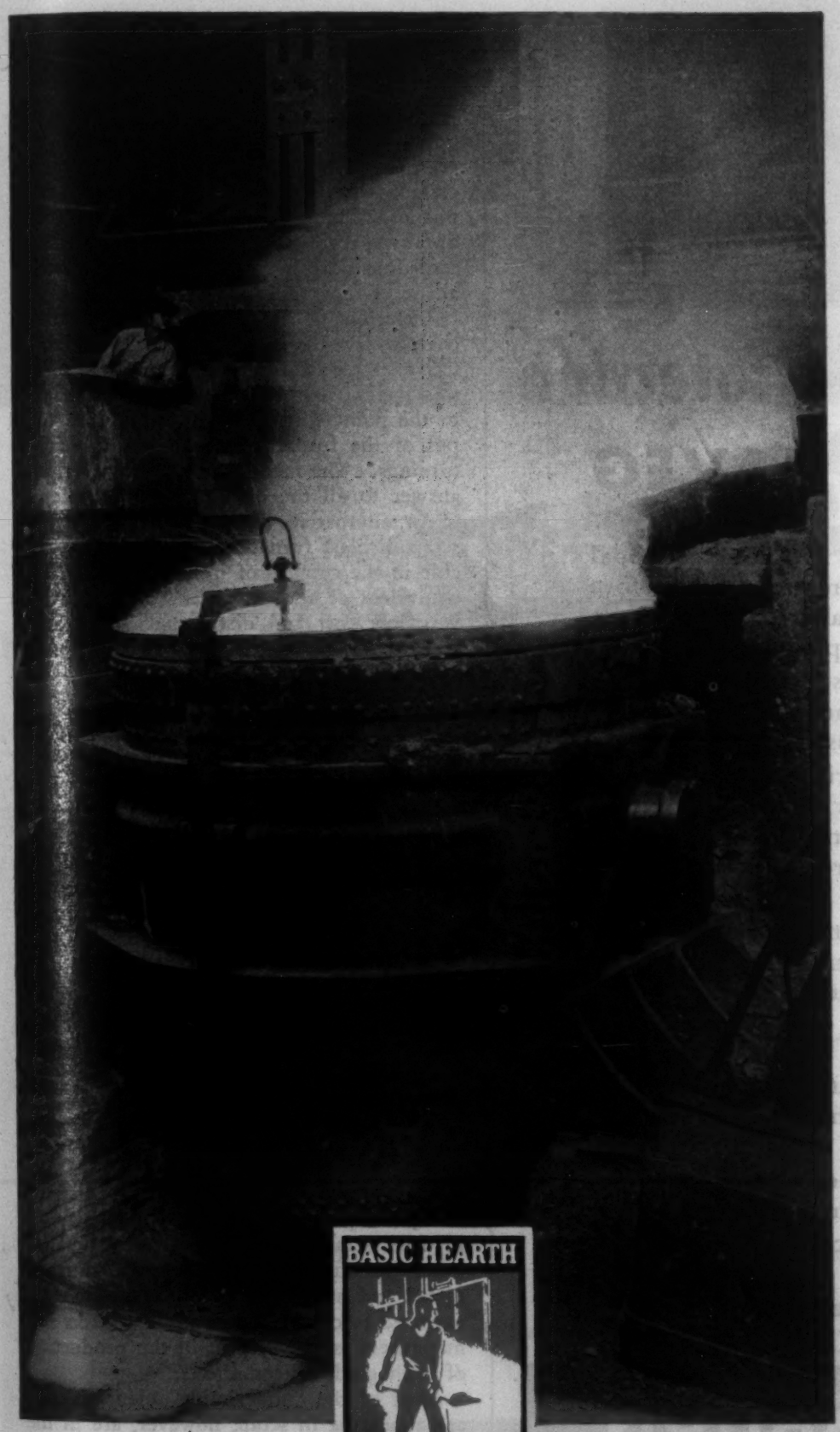
Some companies are finding it cheaper to use turnings instead of paying excess freight on better scrap. One company reports that turnings make up over 50% of all purchased scrap it is using. The importance of alloy turnings as a source of alloys to maintain and increase the production of alloy steel cannot be overemphasized.

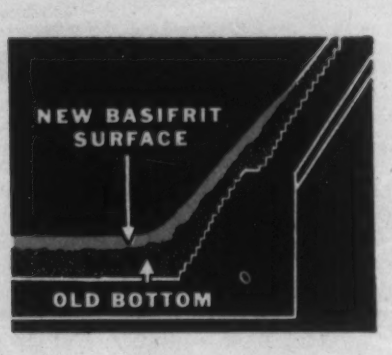
Use of Alloy Turnings

Probably no phase of raw materials development and utilization will pay larger dividends in terms of conservation of critical material and steel output than proper seg-

To Keep Them Pouring

Resurface Open Hearth Bottoms with BASIFRIT





HERE'S a suggestion to add hundreds of heats to the life of that open hearth furnace whose bottom is old and unreliable: Resurface it with Basifrit.

Briefly, here's how: Before the furnace goes down for repairs, wash it down, using coke breeze on the banks and blowing them down with air about every hour. Run slag out every two hours. Continue until the hearth is washed down about 6 inches. Then start resurfacing. Throw in Basifrit with shovels, *without any admixture of slag* The quick-setting Basifrit burns in almost as fast as it can be shoveled. Apply additional layers, one after another, and finish with a light slag wash. Cool until cracks show, then heat up, coat with raw dolomite, and charge. Take off two or three heats before shutting down the furnace for the repairs. The whole job takes 52 to 54 hours.

Resurfacing is just that simple—with minimum lost production. In fact, resurfacing time is not lost time, because it is soon more than made up by reductions in delay time between heats. And you have a sound bottom to protect the quality of your steel.

Basic Refractories Engineers are always at your service on any problem of hearth construction, repair or maintenance.

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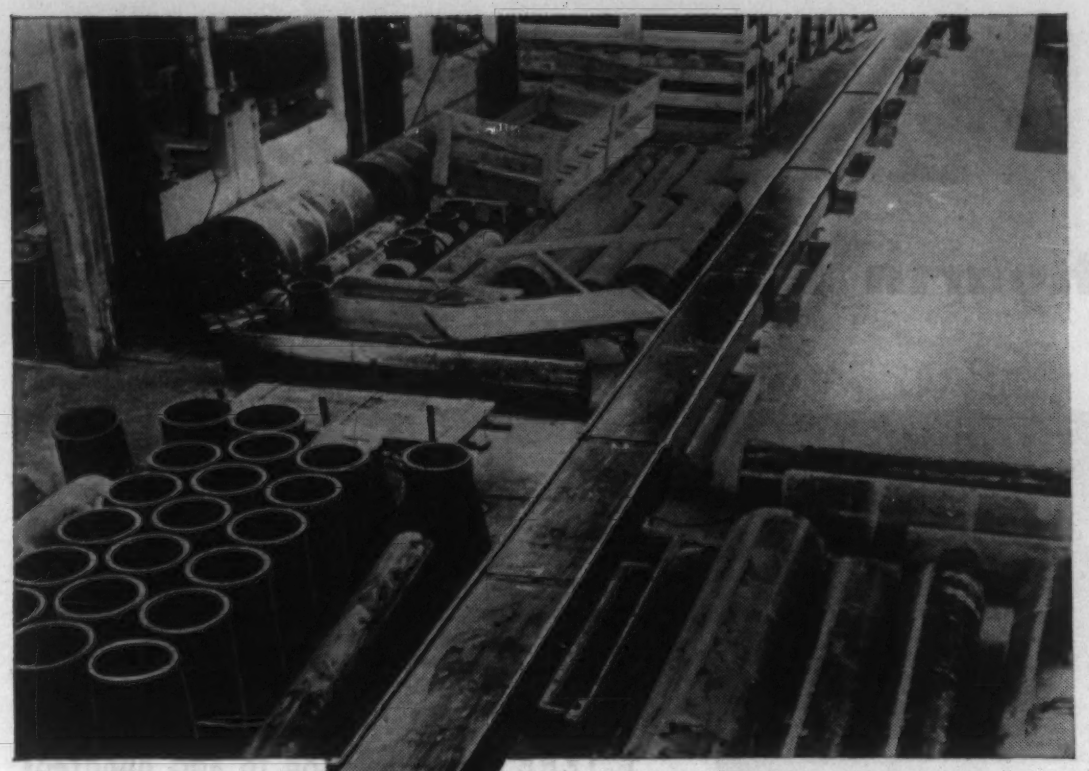

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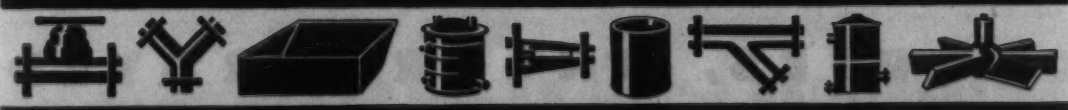

CLEVELAND 550 Leader Building
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regation, preparation and utilization of alloy turnings. A pile of miscellaneous turnings and solids at best is a waste of alloys and at worst is a complete loss of both alloys and iron. Proper segregation and classification will go far to overcome resistance to direct use of turnings.

Methods of using turnings, both alloy and carbon, to best advantage have received much attention. Apparently there is no general answer that will fit each individual steel producer's situation. By and large, however, a difficulty that confronts all users is in the treatment of long and curly turnings.

The British have very largely solved this problem by installing a large number of turnings crushers. About 54% of the bushy turnings produced in England are crushed into short shoveling grades. In certain areas pronounced decrease in output of turnings is traceable to new and improved manufacturing techniques such as centrifugal casting, forging and from other advances in practice.

Inclusion of turnings in blast furnace charges for the production of alloy iron has also received much attention. So far this method has been successfully used up to the point where about 18% of the output of the furnace has been derived from turnings. The method is not, however, the answer to all the alloy turnings problems.

An alternative to using this variety of scrap in blast furnaces appears to be available in the cupolas of iron foundries. The equivalent of alloy iron can be produced at very low cost and distributed where it is required.

Saving Nickel and Molybdenum

Nickel and molybdenum are almost fully recoverable regardless of the processing and use of the scrap. Chromium, particularly in high-chromium grades, is definitely undesirable in any heat where oxidation of carbon has to be done. The effect of carbon on open-hearth slags is well known. Chromium-bearing scrap, therefore, can be used to best advantage only in heats in which the net carbon content exceeds that of the scrap.

One company has successfully precipitated chromium from slags in open-hearth heats with ferrosilicon. More extended use of this technique may be a valuable means of conserving chromium. Vanadium is invariably lost in open-hearth heats when it is introduced as scrap.

Undesirable alloy elements are usually tramp alloys that appear in supposedly alloy-free scrap or scrap delivered on any other specification. The introduction of nickel and molybdenum into heats that are expected to contain only carbon, silicon and manganese is not helpful in the production of high grade silicon sheets.

Most of the "undesirable" elements that are appearing in scrap, however, are in the scrap only because it is improperly classified. One company lost over 40 heats of electric grade of alloy steel before it was discovered that the presumably clean scrap used contained brazing metal.

Adequate housekeeping on the part of steel consumers can be of very great assistance in the solution of these troubles.

—F. E. Vigor. *Blast & Steel Plant.* Vol. 31, Sept. 1943, pp. 1025-1027.

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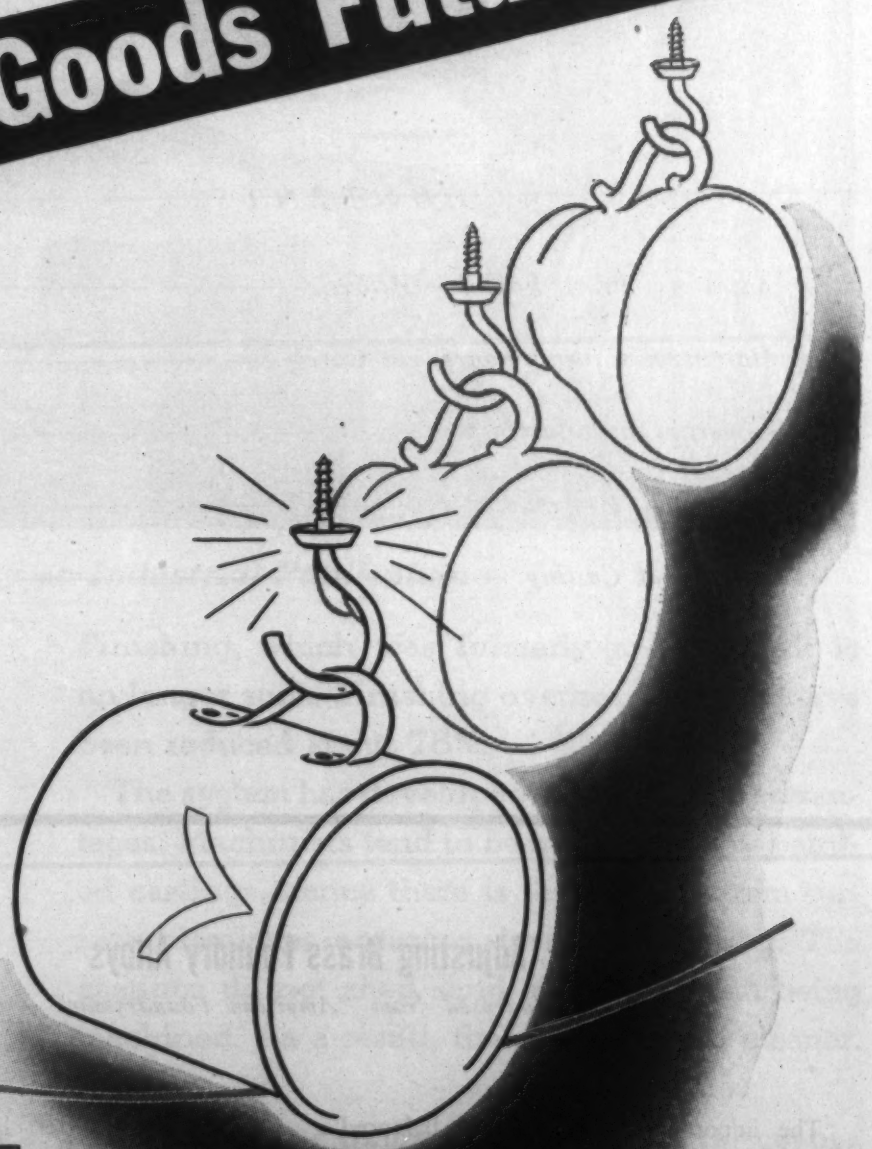

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Adjusting Brass Foundry Alloys

Condensed from "American Foundryman"

The importance of keeping a balanced composition in most non-ferrous alloys is little understood and appreciated by many foundrymen who melt and remelt without correcting additions until the copper content is often too high for the best fluidity and castability.

Specifications which allow this same degree of departure from nominal composition, without regard to the metallurgical effect of each element, are misleading.

By figuring the nominal or desired composition of the well known pressure and general purpose alloys to the lead-free basis and plotting the results on a triangular diagram, the author finds that the leaded bronzes and brasses of good foundry properties arrange themselves along a diagonal line extending from 7 Sn to 21% Zn. Therefore, as an alloying element, zinc is only one-third as effective as tin.

The line referred to in the diagram is the approximate dividing line between the all-alpha or solid solution alloys to the left and above, and the alpha plus delta alloys which occur when the composition falls below or to the right.

For the best pressure resistance and good casting qualities, there should be just a little of the delta tin crystals present, constituting a saturated condition of the alpha. The importance of this is most noticeable in those pressure castings that have the outer skin removed by machining.

The author presents a table of compositions that are commonly used as pressure resisting and general casting alloys in the brass foundries. When these are figured to the lead-free bases (given in the table), all conform approximately to the formula: Tin plus 1/3 zinc equals 7 to 7.4.

All of these alloys lose about 10% of the zinc content in melting and superheating to pouring temperature, and in some open flame furnaces about one-third of the zinc is lost. To keep the alloy in good working condition, this loss should be made up by the addition of zinc to each melt.

The author devotes a few paragraphs to a discussion of how fractured specimens of castings may give a clue to the proper condition. This is regarded as fortunate in the case of brass foundries that do not have chemical control.

In general, the article emphasizes the importance of adding zinc in melting and superheating non-ferrous alloys, and the advisability of making up for shortages of tin or zinc in the ingot metal in order to maintain a balanced composition. It shows that neglect to do so frequently results in a copper content that is 2 to 3% higher than necessary for the castings. For example, the well known 85-5-5-5 alloy is frequently found to run 88% Cu where better physical properties might be obtained with 84% Cu, if properly balanced.

—G. M. Thrasher, *Am. Foundryman*, Vol. 5, Oct. 1943, pp. 7-9.

Aluminum Casting Poured In Cores

Condensed from "The Foundry"

In the procedure at Acme Pattern & Tool Co. for casting aluminum aircraft parts, the usual molding practice is followed in the production of smaller miscellaneous castings. By a new method of pouring directly in the core assembly, a saving of 65% was accomplished in reducing the weight of a wheel case from 228 lb. to 82 lb. Similar practice was developed in casting other parts of the engine.

The upper crankcase is one exception to the practice of pouring entirely in the core. In this case the drag is green sand, but the cope consists of two cores that contain pouring runners and shrink heads.

The composition of the sand mixture for the cope and drag consists of 630 lb. lake sand, 7 lb. oil and 14½ lb. of cereal binder. Proportions for the wheel case cores are the same except for the oil, 3½ lb. be-

Information supplied by an Industrial Publication

Now that time is the essence, a good many ingenious methods of saving it have been developed. One of them deals with the painting of castings.

An organization using a number of fairly complicated castings paints them before machining instead of afterward, as is the usual custom.

The method saves time because (a) it is not necessary to cut and apply masks for machined surfaces, and (b) painters can work faster.

Finishing, which was formerly a bottleneck is no longer such. Finishing overhead charges have been reduced about 75%.

The system has developed supplemental advantages. Machinists tend to be more careful of painted castings, hence there is less trouble from surface blemishes occuring during machining. The castings do not shed sand and dust when being machined. As a result, the shop is much cleaner.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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The Campbell-Hausfeld Co.

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ing used. For the jacket and side rail cores of the cylinder head oil is raised to 10 lbs. A typical analysis of this latter mixture is: Moisture 1.68%; dry permeability 195; tensile strength 107.5 psi.

Large risers are used on engine castings to assure adequate feeding to various sections. For example, a cylinder head as-cast weighs about 215 lb., but about 130 lb. of this consists of gates and risers. The metal used is a British alloy. Melting is accomplished in 1000 lb. gas-fired tilting furnaces. Nitrogen is used for fluxing in order to remove oxides and gas.

After fluxing, the temperature is raised slightly above 1400° F., and pouring is done at about 1300° F. A careful check is made of composition and temperature of each heat. Test bars also are poured from each for subsequent analysis.

Removal of gates and risers is an extensive operation. Chipping proved a laborious process, so the electric arc was used to cut away the risers from the upper crankcase. Using reverse polarity, most of the excess metal is removed in about 30 min. Risers on the cylinder head are removed by drilling and chipping.

After gates and risers are removed, castings are heat treated, the stress relieving operation consisting of heating for 5 hr. at 55° F. Final sand blasting precedes inspection.

—William G. Gude. *Foundry*, Vol. 71, Sept. 1943, pp. 96-99, 178.

Properties of Silumin

Condensed from "Aluminium"

The liquidity (ability to fill the mold) of silumin (aluminum-silicon) is particularly good in the eutectic. Magnesium-bearing alloys with about 12% Si, and wall thicknesses of only 2.5 mm. (0.1 in.) and even less for large areas can well be cast, while other aluminum alloys have a limit at about 3 mm. (0.118 in.). Shrinkage is 1 to 2% for sand castings and 0.5 to 0.8% for chill-mold castings; if silumin is refined by sodium, the shrinkage becomes still less, which is almost like that of the eutectic grey casting.

Of all aluminum alloys, silumin has the least tendency to hot-embrittlement and hot-cracking. They are rated as: Al with 1.6 Si, 0.26% Fe, 100%; Y alloy with 4 Cu, 2 Ni, 1.5% Mg, 93.8%; German alloy with 2 Cu, 10% Zn, 83.3%; American alloy with 8% Cu, 62.5%; magnalium with 8% Mg, 53.3%; Al with 0.22 Si, 0.20% Fe, 6.25%; Al with 0.07 Si, 0.053% Fe, 5.00%; silumin with 12.2% Si, 0.00%.

Hot-brittleness is greatest between 0.6 to 1.62% Si, and decreases with further silicon content; above 1.88% Si, the tendency to cracking is very small. Tensile strength is about 17 to 24 kg. per sq. mm. (24,000 to 34,000 p.s.i.), bending fatigue strength 4.5 to 10 kg. per sq. mm. (6,400 to 14,200 p.s.i.).

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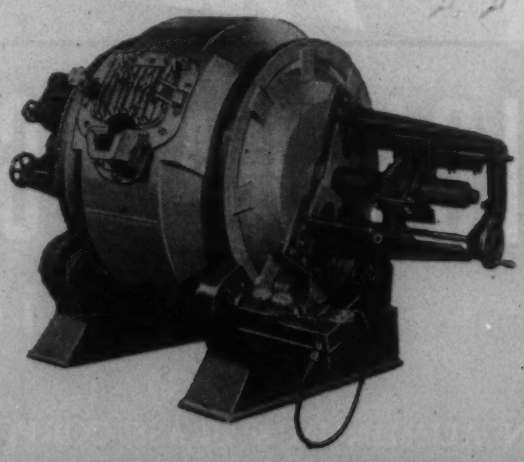

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Silumin γ has a tensile strength of 25 to 34 kg. per sq. mm. (35,600 to 48,400 p.s.i.), with 6.5 to 12 kg. per sq. mm. (9,200 to 17,000 p.s.i.) bending fatigue strength. Cold pouring and fast solidification produce better basic structure, better mechanical properties and greater density in the castings.

The addition of sodium has a far greater refining effect than any other element, even beryllium, which has a marked influence on crystal change.

—E. Piwowarsky. *Aluminium*, Vol. 25, Feb. 1943, pp. 78-81.

Core Sand Reclamation

Condensed from
American Foundrymen's Assoc. Papers

The two papers abstracted herein were presented at the 1943 A.F.A. Convention, and describe a new device for reclaiming used core sand, particularly oil bonded core sand, one from the viewpoint of the user and the other from that of the maker of the equipment. Various size units are available with capacities from one to ten tons per hour at respective costs of approximately $20,000 and $60,000.

A unit consists of a rotary oil or gas-fired kiln, fans, cooling unit, dust collector and automatic safety controls.

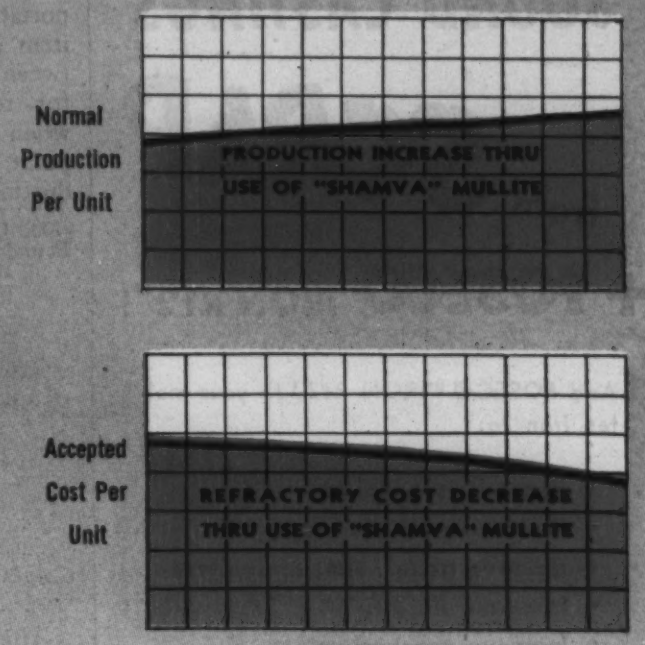
In operation, the sand is shaken out and either crushed in revolving breaker screens or crushers to ¾ in. size and passed over vibrating screens for reduction to 20 to 30 mesh. Metallic material is removed. The screened material is then passed into the high end of the inclined kiln heated to a temperature from 1000° F. to 1500° F. The heat, combined with the abrading action caused by the rotation, removes all traces of binder, and produces a clean sand nearly the same color as new sand.

Longueville and Myers made comparative tests on core mixes from new and reclaimed sand. Both produced cores that were entirely satisfactory, although differing in some respects. The reclaimed sand produced lower baked tensile strength and lower green and dry permeability, due to being somewhat finer and having wider distribution. Both sands contained at least 99.5% silica, but the reclaimed sand contained 16.9% of fines compared with 5.3% in the new sand.

Hartley estimates that the reclaimed sand will cost $1.44 per ton or less, depending on the capacity of the unit and the tonnage handled. This compares very favorably with a cost of $3.00 or more per ton for new sand delivered to points near the pits and $9.00 per ton to the West Coast foundries.

Successful units have been installed at Wright Aeronautical Corp., Lockland, Ohio; Buick Motor Co., Flint, Mich.; and Ford Motor Co., Dearborn, Mich. Other units are being installed.

Sand reclaiming units are of particular



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The superintendent who has selected "Shamva" Mullite for his furnace construction is finding this outstanding super-refractory of tremendous help in the drive for volume because—

PRODUCTION IS CLEARLY INCREASED as a result of the superior service life of "Shamva" Mullite. At extremely high temperatures it does not soften and slag away. Permits all-out production with a minimum of shut-downs.

LABOR IS MORE PRODUCTIVE because man-hours formerly spent on repairing and rebuilding can now be devoted principally to getting out added production.

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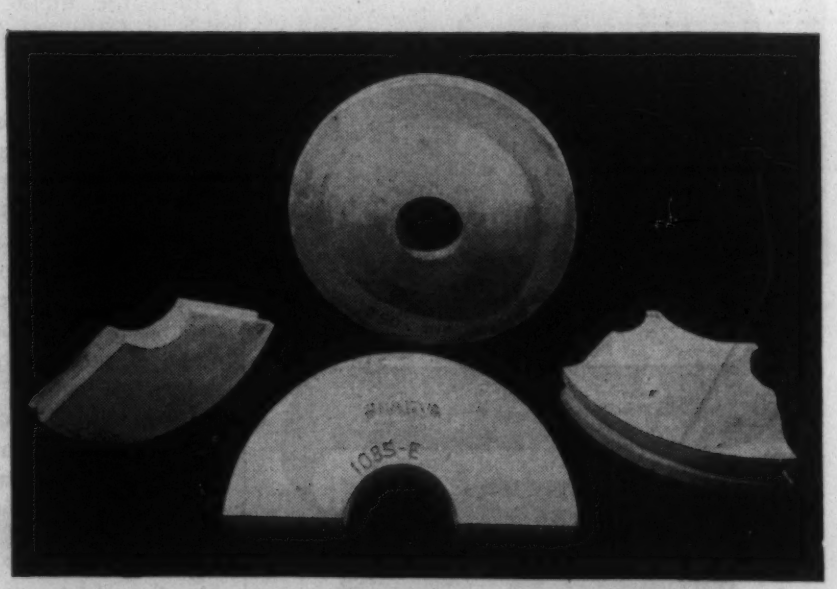

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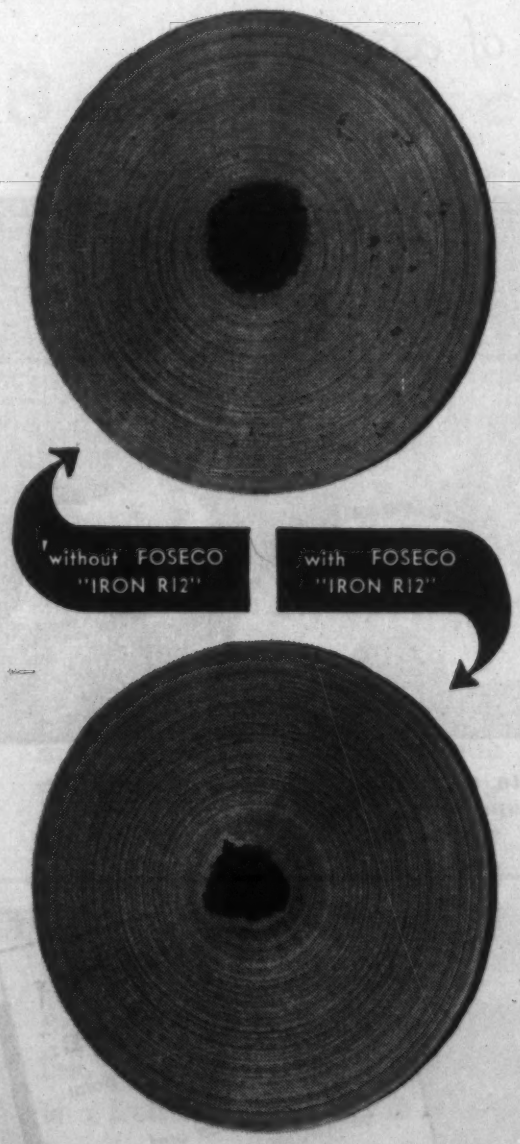

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interest now because of limitations on transportation facilities for new sand. Another item is the elimination of the cost of between 50 cents and a dollar a ton required for removal and disposal of used sand when not reclaimed. Also, more uniform plant control of sand with increased production and less casting rejects is provided.

—D. L. Longueville & Jay Myers. *Trans.* Am. Foundrymen's Assoc. Vol. 51, Sept. 1943, pp. 198-206; W. L. Hartley, *Ibid.*, pp. 207-209

Centrifugal Casting

Condensed from "Foundry Trade Journal"

This paper deals with the casting of tubular pieces for the manufacture of internal combustion engine piston rings and cylinder liners, for which the author's firm have recently equipped their foundry with a James centrifugal casting machine. In this system of casting, the molds, which are cylindrical in form, are rotated about a horizontal axis.

The James machine is designed with three shafts running one inside the other. The outer shaft carries the driving and braking mechanisms, and the face plate to which the mold holder is fixed. Inside this slides a second shaft, to which is attached the front plate, which has to be moved out of the way in order to remove castings from the machine. Inside this is the plunger shaft. The function of the plunger is to seal the inner end of the mold, and also to eject the finished casting.

The machine is driven by a belt from a variable speed motor that provides an infinite range of speed from 500 to 1500 r.p.m. at the machine spindle. Molten metal is poured into the receiving basin at the outer end of the spout and runs into the mold until it is filled up to the level of the opening in the front plate, when any excess metal poured is thrown out and is caught by a sheet metal guard.

As soon as the temperature of the casting falls to 900° C. (1650° F.), a hand wheel, which operates the plunger, is turned, moving it forward and thus ejecting the casting.

When the machine was started up, many difficulties were encountered. One was the inability to get the small amounts of metal, which the machine is able to take, hot enough from the cupola. Even the smallest cupola will melt about 1500 lbs. hourly, and the difficulties connected with tapping 10 to 20 lbs. every two or three min. are readily imagined.

Furthermore, all the piston-ring specifications acceptable for aircraft limit the carbon contents of the iron to below 3.5%, and the cupola was delivering iron with 3.6 to 3.8% C. Eventually, duplexing the metal was tried by melting a charge in the cupola, transferring it to a crucible furnace for superheating, and at the same time making additions required to bring the metal to correct chemical analysis.

—G. E. Alexander. *Foundry Trade J.*, Vol. 71, Oct. 7, 1943, pp. 109-110.

For CLEAN STEEL and INCREASED PRODUCTION

- **Lunke-Rite**—an extremely effective exothermic, powdered compound for the control of piping in steel ingots poured *with or without*, hot tops; and in steel castings. It increases ingot yield considerably. The additional heat created has a beneficial effect on quality of steel by reducing rate of cooling in center section of ingot, which has been found to prevent internal cracks and laminations. This fact is especially important for large forging ingots.—Also used for fitting ladle stopper into nozzle;—as cover on steel in ladle where duplexing or reladling is practiced;—as cover on hot metal being transported a distance from blast furnaces;—etc.—LUNKE-RITE is available in grades to suit various needs. Information upon request.
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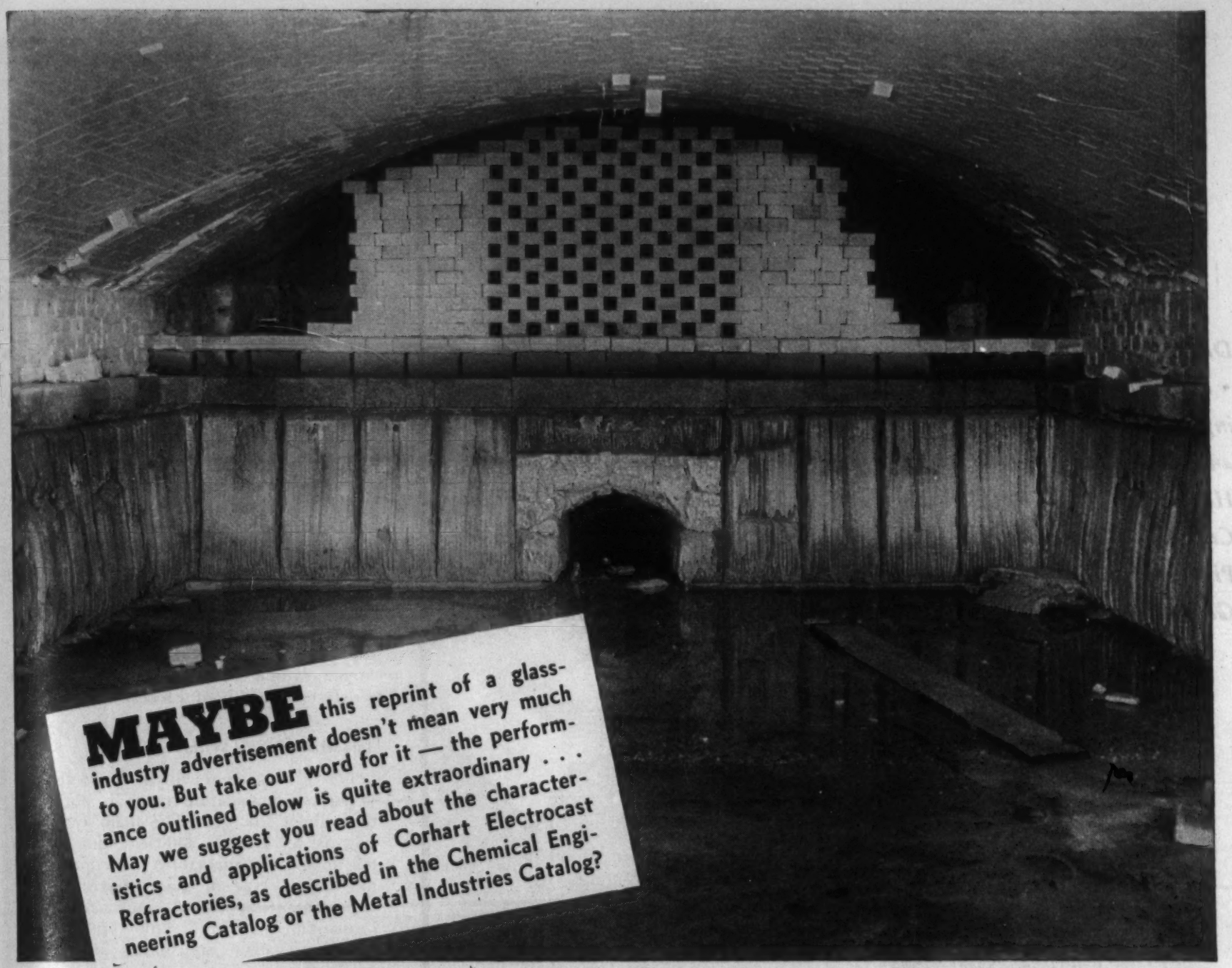

MAYBE this reprint of a glass-industry advertisement doesn't mean very much to you. But take our word for it — the performance outlined below is quite extraordinary . . . May we suggest you read about the characteristics and applications of Corhart Electrocast Refractories, as described in the Chemical Engineering Catalog or the Metal Industries Catalog?

Floor-level Throat Runs Thirty-one Months!

FOR 31 months, the furnace above operated at high production on milk-bottle glass. It is obvious that in a campaign of this length, with a floor-level throat, no refractory could survive unless it were possessed of extraordinary quality and resistance.

The throat-cover blocks are Corhart* ZED Electrocast. As the photograph shows, the ZED throat not only survived, but apparently had considerable usefulness remaining at the end of the run.

We would be glad to discuss your tank problems with you. *Address:* Corhart Refractories Co., *Incorporated,* 16th and Lee Streets, Louisville, Kentucky.

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Steel Weldability

Condensed from "Welding Journal"

The general purpose of a research program conducted by Rensselaer Polytechnic Institute was to evaluate the weldability of steels for the arc welding fabrication of war materiel, and to select optimum welding conditions. The principal approach was by direct measurement of cooling curves associated with a variety of welding conditions, plate thicknesses and plate temperatures.

The specific purpose was to obtain measured cooling curves and maximum heat-affected zone hardness for the first and last passes of butt and fillet welds in ¼, ½, 1 and 1½ in. A.S.T.M. A 131-39 plain low carbon ship steel. For each thickness at least four combinations of weld energy input per inch were used.

A Jominy hardenability test was run on each different heat of steel. For the bulk of the work alternating current was used because it gives a steadier arc with less magnetic disturbance at the ends of the weld.

It was found that the first pass in butt welds always cools more slowly than the last pass. The first pass was particularly studied because of the general experience that difficulty with cracking is found more common therein, probably because of the lack of mechanical support of that pass. The studies were conducted between 32° and 400° F., and the investigation was limited to the effect of welding conditions in the base metal in the heat-affected zone.

It is becoming more recognized that both the metallurgical structure and the response of the base metal to welding determine cracking and the ductility of the joint. Welds were made with G.E. 6 WF-H2A8 automatic arc welding equipment, the electrodes being Murex Type F, suitable for down-hand welding and for horizontal and positioned fillets; also for deep groove work, for cover beads, for straight or reversed polarity, or for alternating current. Welding current was provided by a 750 amp. G.E. arc-welding transformer using the 100 v. open-circuit connection.

The entire metallurgical behavior of the steel adjacent to an arc weld is a function of time-temperature relations above the equilibrium critical temperature and also of the cooling rates through important sub-critical temperature ranges. The latter are most important and most subject to control. It was found that many alloy and higher carbon steels could not be welded satisfactorily without preheating the plate.

Important Range Within 200 Deg.

For most steels it will be found that the important temperature range is not wider than about 200° F. The main consideration is to provide sufficient time within the important temperature range to produce the desired type of grain structure. The important temperature range for transformation is between 1100° and 900° F. for plain carbon and nickel and manganese steels.

When steels are welded with a plate preheat of about 400° F., as compared with room or lower temperature, there results an appreciable stress relief and tempering of any residual martensite, with a considerable improvement in ductility and with very little change in hardness.

By means of relationships described in this report it is possible to predict welding conditions to give the all-fine-pearlite or the all-bainite type of structure. For many steels it may be necessary to make a compromise between the desirable structures and the normally brittle martensitic structures.

The cooling rates and possibilities of extension of the measurements by mathematical methods should be valuable in studying the production of stresses and the formation of cracks. Cooling rates, or more precisely cooling curves, are principally determined by weld energy input per unit length of weld, plate thickness, plate temperature and plate geometry.

In the experiments at Rensselaer the theoretical mathematical solutions were constantly checked with the actual experiments, and reasonable agreement was found invariably. Hence, for those conditions where actual experiments were not made it can be assumed that the mathematical data will hold true.

A study of the data will give an excellent

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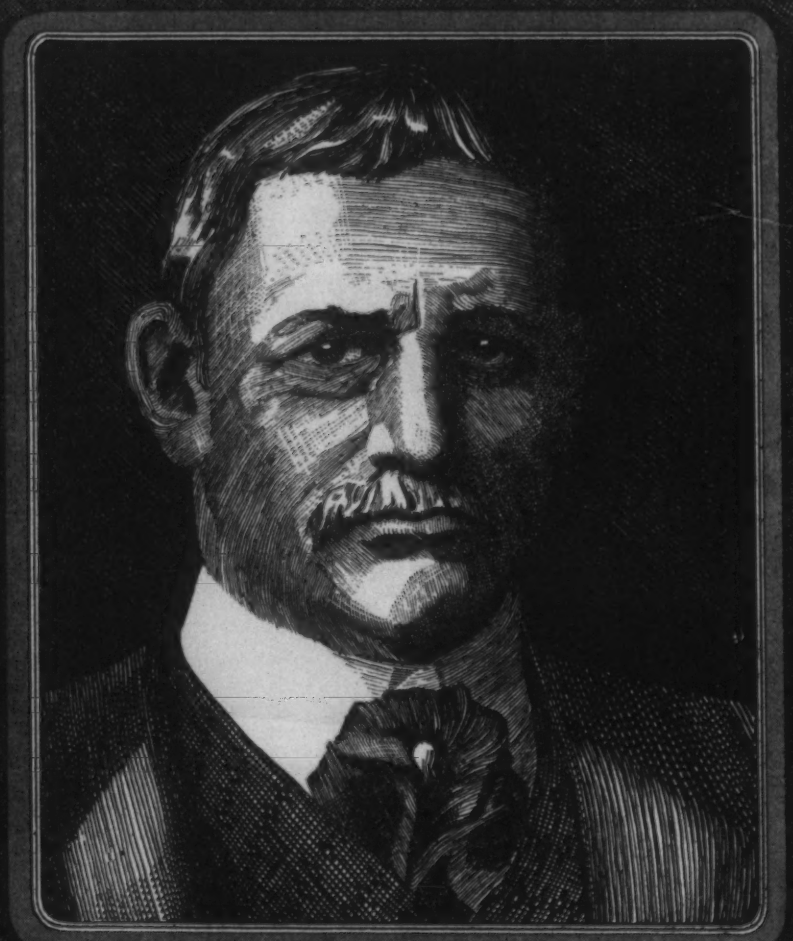

Elihu Root

"We deem the independence and equal rights of the smallest and weakest member of the family of nations entitled to as much respect as those of the greatest empire."

Elihu Root will long be remembered for his brilliant statesmanship as secretary of war, secretary of state, United States senator for New York, and other responsible government positions, from 1899 to 1918.

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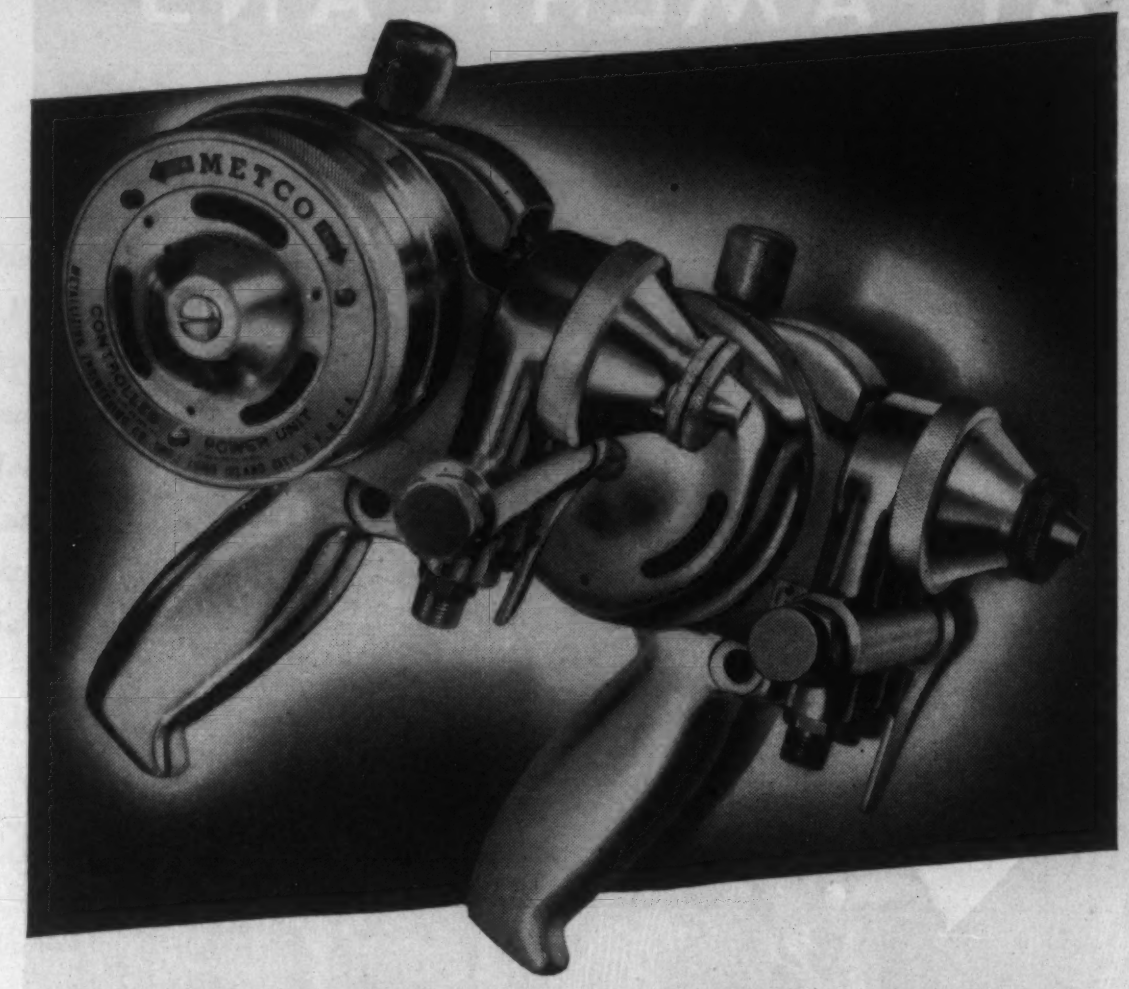

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picture of the importance of the plate thickness in determining whether a steel can be readily welded. Reasonably slow cooling rates can be obtained in the thinner plate sections, but it is with only very high degrees of plate preheat that similar thermal cycles can be obtained in heavier plates.

Behaves as Infinitely Thick Plate

In the range between ½ in. and 1 in. the plate will behave at first as a thick plate; then, as temperature drops and heat is conducted to the opposite surface, the behavior will change in the direction of becoming a thin plate. With low power input and high arc travel speed, even a 1-in. plate behaves essentially as an infinitely thick plate during the significant part of the thermal cooling cycle.

The fact that the metal melts and leaves a pool of molten metal trailing the electrode has the effect of an apparent increase in heat input to the plate. One of the fundamental principles for the avoidance of cracking of welds in hardenable steels is to temper the structure before the temperature has dropped much below the martensite-forming range.

If a cascade technique is arranged so that a second pass is deposited before the temperature in the zone adjacent to the first pass drops below a certain temperature, the heat of the succeeding pass can temper the preceding pass and help to prevent cracking. To determine the time available between passes for such cases, a special mathematical solution has been developed.

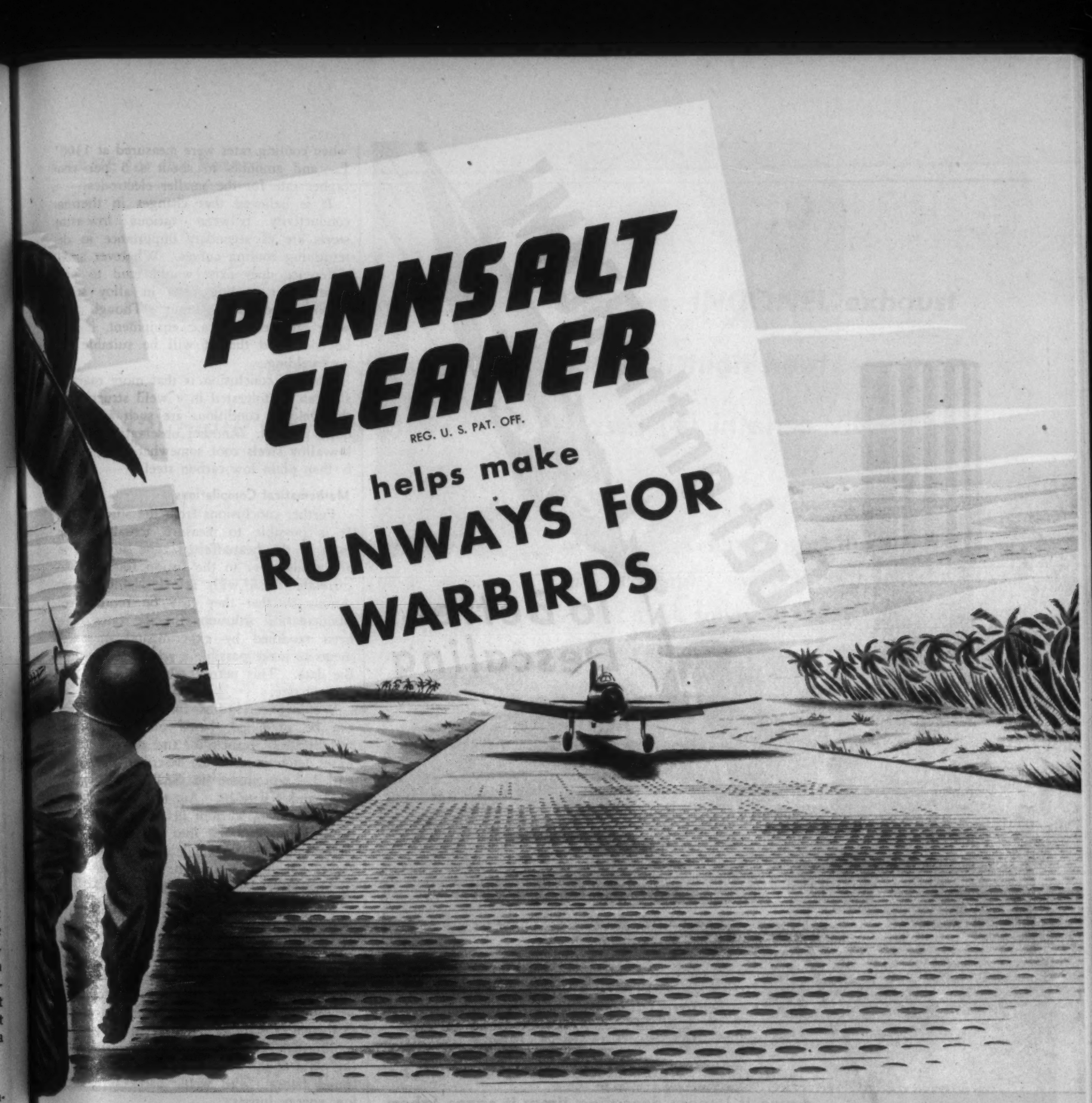
The cooling rate at any temperature is independent of travel speed; therefore, except for small initial differences, the time required to fall to any temperature must be independent of travel speed. Plates cool very little more rapidly when welded at 37° F. than at 72°. Consequently, trouble experienced with cracking at low temperatures is not so much due to differences in cooling rate as to differences in the ductility of the plate material being welded at these low temperatures, particularly that ductility measured in the presence of a notch.

First Pass Cools Slowly

Invariably in numerous experiments under varying conditions the first pass cools much more slowly than the last pass. This is because metal is deposited more compactly in the first, resulting in much less conducting surface from the deposited metal to the plate. Also, when the first pass is being deposited, the arc being down in the groove tends to radiate much more of its heat to the plate than when operating on top of the plate in the last pass.

The last pass may cool by conduction of heat both laterally and in the direction of plate thickness. The most severe conditions from a metallurgical standpoint are obtained in the last pass. As a result of these findings, it was decided to discontinue the measurement of first pass cooling rates. Where cracking is more prevalent in the first pass, it is due to the cooling of unsupported weld metal and not so much to any adverse effect of cooling rate.

In welding the 1-in. ship steel there was found the tendency for 3/16 in. electrodes to produce a higher cooling rate than ¼ in. electrodes. This effect was observed



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The landing mats are carried on a chain conveyor through the following sequence of operations: First, soak cleaning with Pennsalt Cleaner in a 1200-gallon tank at 212° F.; then a cold water rinse in an 800-gallon tank; finally, a hot rinse in an 800-gallon tank containing rust inhibitor.

To date millions of square feet of landing mats have been cleaned with Pennsalt Cleaner with highly satisfactory results . . . This is another wartime cleaning job which demonstrates again the effectiveness of this famous family of metal cleaners.

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The Bullard-Dunn Process, the "up-to-the-minute" descaling method, meets the stringent requirements of war-time production because it lowers descaling time; it saves labor; it removes scale completely from internal as well as exposed surfaces; it changes no dimensions; it is dependable; it is easy to operate; it is practical. What more can one ask for present as well as post-war production?

Send data and representative samples to

BULLARD-DUNN

DIVISION OF THE BULLARD COMPANY

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when cooling rates were measured at 1300° F. and amounts to about a 5 per cent higher rate for the smaller electrodes.

It is believed that changes in thermal conductivity between various low-alloy steels are of secondary importance in determining cooling curves. Whatever small difference does exist would tend to produce lower cooling rates in alloy steels at the same energy input. Though data were gathered with a.c. equipment, it may be concluded that it will be suitable for d.c. welding.

Another conclusion is that more martensite can be tolerated in a weld structure if the welding conditions are such as to require preheat. Another observation is that low-alloy steels cool somewhat more slowly than plain low carbon steel.

Mathematical Compilations

Further conclusions from the studies are: It is possible to measure actual cooling rates in the heat-affected zone adjacent to arc welds close to the fusion line, and to correlate these with actual welding conditions so that they may be reproduced. Mathematical solutions for the rates have been modified by experimental measurements to make possible a wide extension of the data. This permits duplication of any desired rate.

Welding conditions for different steels can be predicted, based on fundamental metallurgical principles and simple tests. Rates determined on the described ship steel will be reproduced in SAE 1035, NAX 9115 and NE 8620. Arc travel speed, arc voltage and arc current in amperes may be conveniently grouped into a single factor, energy input per unit length of weld in joules per in., as a factor in determining cooling rate.

The only cooling rate factors to be considered are energy input in joules per in., plate thickness, plate temperature and joint geometry. Complete data for a new plate thickness are obtained by making experimental measurements at only two plate temperatures, the rest to be ascertained by mathematics. In ½ in. plate much higher cooling rates are found near the surface of the plate at the edge of the weld, than are found beneath the weld, particularly for low energy inputs.

—W. F. Hess, L. L. Merrill, E. F. Nippes, Jr. & A. P. Bunk. *Welding J.* Vol. 22, Sept. 1943, pp. 377s-422s.

Bending Copper Tubes

Condensed from "American Machinist"

A large number of different size copper tubes bent accurately to various shapes, with close tolerances for length, is made for the Navy by International Harvester Co. Most of the tubes have compound or reverse bends, impossible to produce on standard tube bending machines, and must have no restrictions or folds. Each tube is inspected by dropping a steel ball through it, also with special checking fixtures and with hydrostatic pressure twice normal.

Where tubes have very thin walls and are over ½ in. in diam., they are filled be-

On Pan-American Clippers, INCONEL exhaust manifolds are subjected to (1) high heat (2) quick starting (3) corrosive gases (4) intense vibration

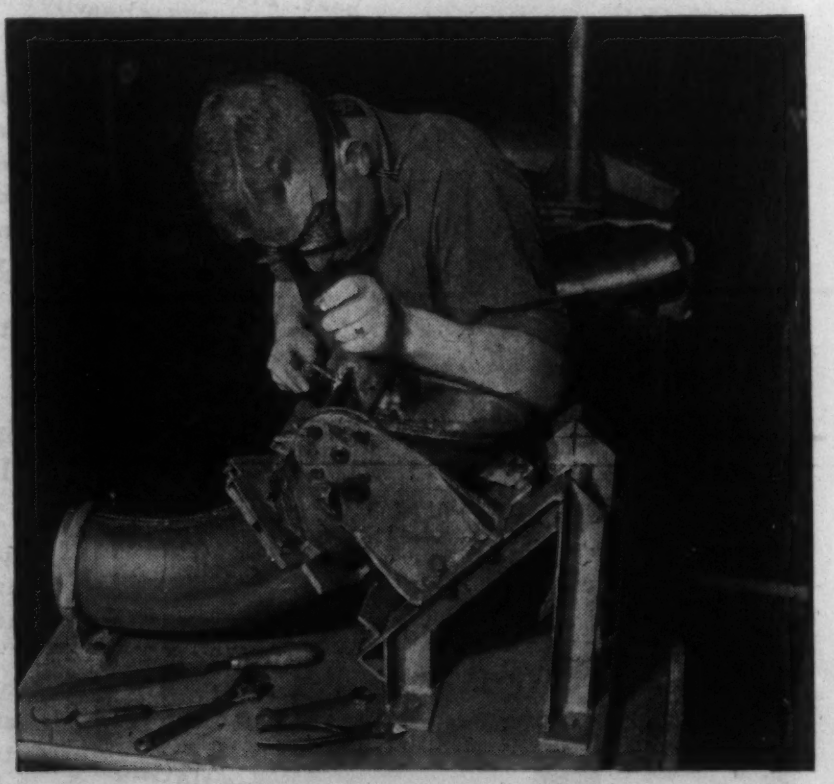
The lightweight exhaust manifolds... welded of .043 in. INCONEL sheet... installed on Pan-American Clippers before the war have helped to "keep 'em flying."

In service, they encounter sudden temperature swings from the cold start to 1500° F., and higher... the corrosive blast of exhaust gases from high octane fuel... incessant and intense vibration.

Despite these destructive factors... and the very light gauge of the sheet used... many of these INCONEL manifolds have seen more than 5000 hours of flying service *without repair*.

★ ★ ★

*The details of this use of INCONEL are published in the belief that they will be of interest and value to engineers and designers working on similar problems, even though the use of INCONEL today is restricted to approved applications.



Material for exhaust manifolds must have good working qualities and especially good welding qualities . . . two definite advantages of INCONEL. It can be formed into complicated shapes in drop hammer as well as in press work, and welded to produce ductile joints that endure constant vibration without cracking.

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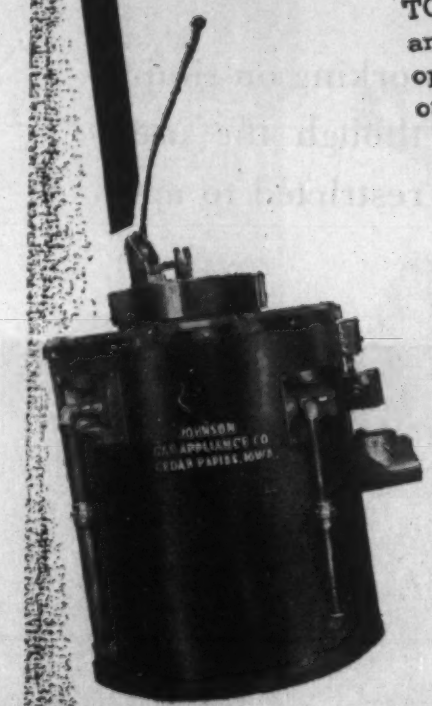
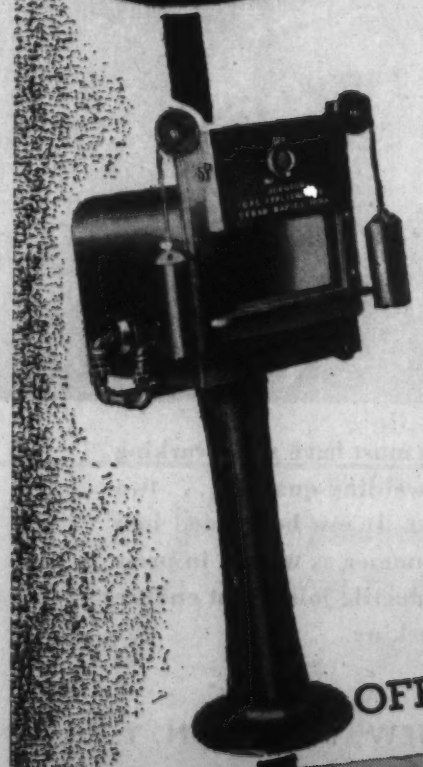


TODAY, order your Johnson furnaces, and have them in your plant, ready to operate quickly. We give you delivery in one week.

No. 575 Pot-Hardening Furnace Fully Lined with 8" Insulation

Here's a pot-hardening furnace hard to beat. Fitted with automatic lighting device, No. 575 is heavily insulated with 4½" firebrick, backed up with 3½" insulating block. Lid-lifting mechanism easily raises cover and locks it in UP position. Burners are located near top of combustion chamber to insure longer pot life. Economical to operate. Large blower assures maximum performance. Steel pot 14" wide, 20" deep. $375 F.O.B. Factory.

Also available in pot sizes 14 x 16, and 14 x 18.



No. 130-A Hi-Speed Steel Heat-Treating Furnace. . .

Counter-balanced door opens upward, so tools can be placed or removed without fully opening door — thus preventing temperature drops. Fire-box is 7¾" high, 13" wide and 16½" long. Equipped with Carbofrax hearth and ¼ H. P. blower, and lined with insulating refractory. Four-burner model, illustrated, for 1400 to 2000° F., complete with motor and blower, $295 F.O.B. Factory. 6-burner job for 1800 to 2400° F., complete, $325. Prices F.O.B. Factory.

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fore working with untreated dry silica sand. Small tubes that are to be bent cold are annealed to cherry red with a city-gas torch as they lie on bricks on a welding stand, then dipped into cold water. Tubes over ½ in. in diam., filled with sand, are heated with an oxyacetylene torch uniformly over the bending area just prior to working.

To make the fixtures a steel rod, the same diameter as the tube outside, is formed accurately by hand to the needed shape. This is studied for sequence of bends, whereupon a fixture is built by welding together steel sections to suit the shape of the finished tube.

In operation, the end of the tube is clamped in position, then the tube is gradually drawn into shape around the contour of the fixture with care and just the right amount of manual pressure. Some fixtures have sliding blocks or quick-acting clamps, easily moved out of the way, and arranged so that the finished tube can be drawn out easily.

The minimum inside radius of the bend should be greater than the outside diameter of the tube to prevent folds. Often a steel plug with an extended handle is fitted into a tube end to give the bender a grip that will not cause distortion. The handle is held by threading onto the coupling nut already assembled on the tube.

Usually one end of the tube is given a preliminary bend in the channel section of the fixture; it is then transferred to the main body of the fixture and carefully wrapped or wiped around the fixture contour. The first end of the tube is located by bringing the coupling nut against stops.

Tubes are filled with sand by first driving a short plug in one end and pouring in the sand from the other end. The sand is tamped down by striking the tube exterior with a wooden block. When filled, the plug with the extended handle is driven into position, then a tapered collar is driven over that end of the tube to compress the tube against the handle and to prevent the mouth of the tube from enlarging.

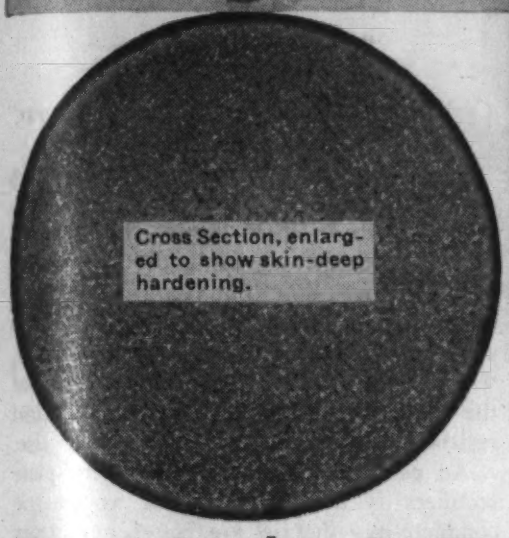
Fixtures must be made with relatively thin sections where the tube is being bent hot, so that the body of the fixture will not carry heat away from the tube too rapidly.

Tubes are cut off from mill lengths at a work bench fitted with a bench-type, abrasive cut-off machine. A wood guide channel keeps the tube lengths square with the cut-off wheel. Stops in this channel permit cutting off tube lengths within plus or minus 1/32 in.

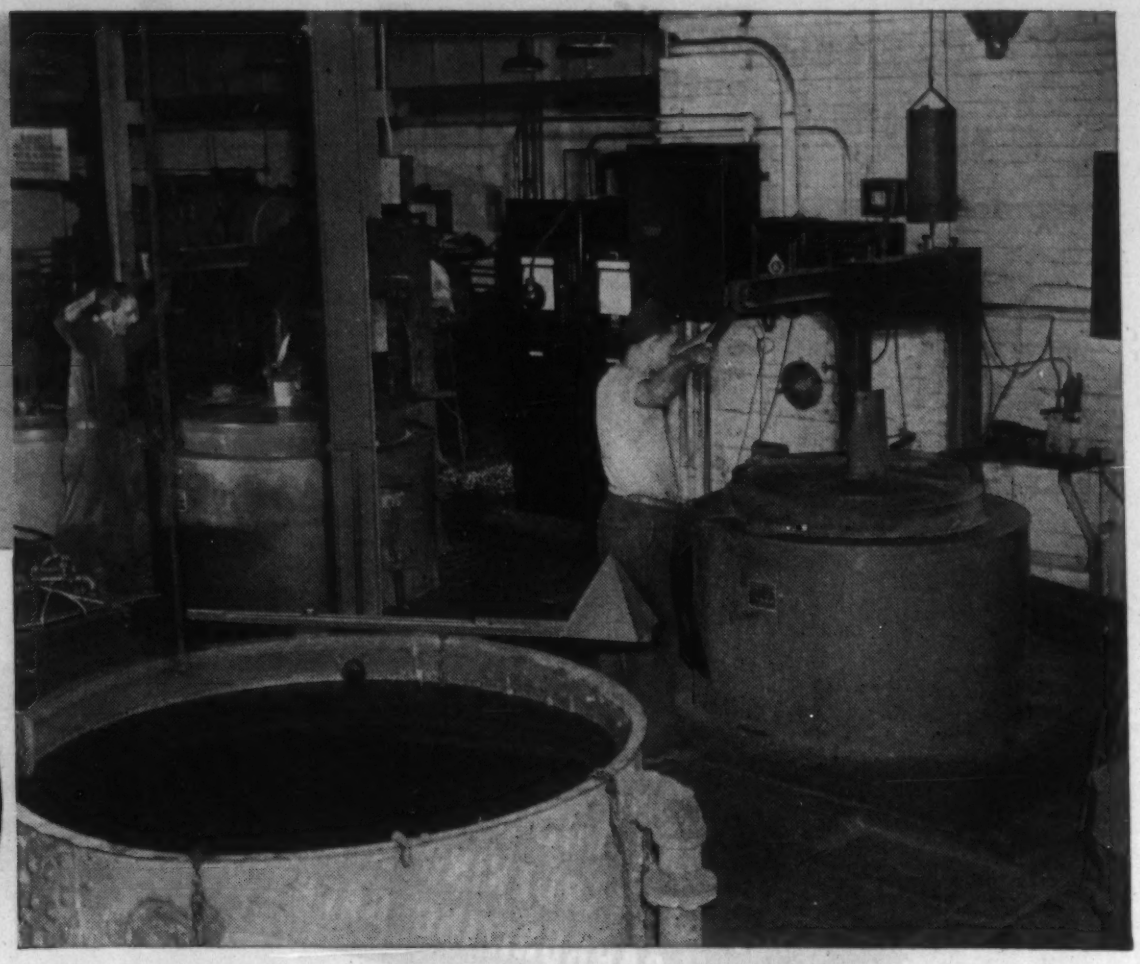
Tubes that are to be fitted with ferrules before bending are cut to the finished lengths required. For larger tubes bent hot, or to be threaded after bending, tubes are made 1 in. or more longer on each end to provide a grip for the bending handles, and are cut to finished length after bending.

Cut-off tube lengths are burred at each end with three-corner hand scrapers. Then, coupling nuts are assembled on the tubes that are to be fitted with ferrules before bending. To apply a ferrule the tube is gripped in a special vise, the ferrule is located over the tube, the tube is swedged out to hold the ferrule in place by driving a tapered steel drift into the end of the

A Yale Padlock's shackle, actual size.



Cross Section, enlarged to show skin-deep hardening.



Two of Yale & Towne Mfg. Co.'s Homocarb Furnaces, used in the Stamford, Conn., plant for shallow-case gas-cyaniding of lock shackles as well as for straight Homo Carburizing.

How Yale & Towne Harden Shackles *Skin Deep*

The problem in hardening the above-shown shackle for a Yale padlock is to give its tough but soft steel a file hard non-brittle skin. This skin or case must be only 0.008″ to 0.012″ thick, depending on size; it must be within a fraction of a thousandth of the specified thinness; and it must be extremely uniform.

These "musts" have long been met by the use of one of the old-established case-hardening methods. But, when "Homo-cyaniding" became available a few years ago, Yale & Towne executives decided to review the situation. They investigated; tried the Homo-cyanide method thoroughly, and have now adopted it because it gives great uniformity and is clean, quick and automatically controlled. The operation is as follows:

Twenty-five hundred shackles (260 lbs), are divided among three alloy trays, which are then nested in the Homocarb Furnace.

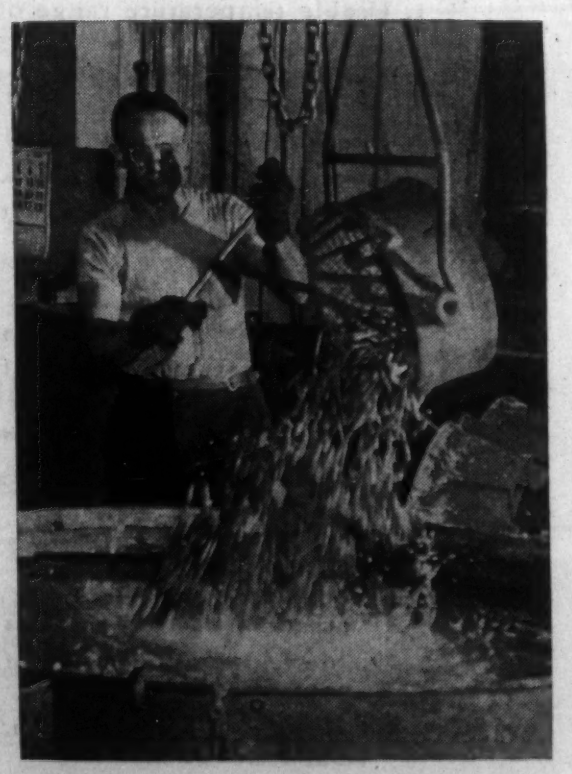
Forced-convection heating by the genuine Homo Method brings the load rapidly and uniformly up to the gas-cyaniding temperature of 1550 F.

After loading the furnace the heat-treater starts an automatic injector which feeds Homocarb Fluid into the furnace. This fluid "cracks" to form Homocarb gas; both prevents scale and carburizes. Then, at the proper point in the cycle, a small, steady flow of ammonia is admitted.

The ammonia and Homocarb gas, mixed and distributed through the load, reacts with the steel to form the intensely hard case required. Because the Homo Method distributes the mixture so thoroughly, the case is highly uniform; and because the Micromax Temperature Control holds the heat so constant, the thickness of the case is regulated with great exactness by simply soaking for the desired time.

The heat-treater therefore has only to watch the time, and quench promptly in brine, to get the correct structure. There are practically no rejects of these urgently war-needed parts.

If you have a gas-cyaniding problem, outline it and an L&N engineer will either call or send Catalog T-623, as you prefer.



Quenching shackles in brine. The pyramidal spreader, on end of steel rod, scatters shackles so that each is quickly and thoroughly quenched to make its Homo-cyanided surface file-hard.

Jrl Ad T-623(17)

A Slogan For Every American

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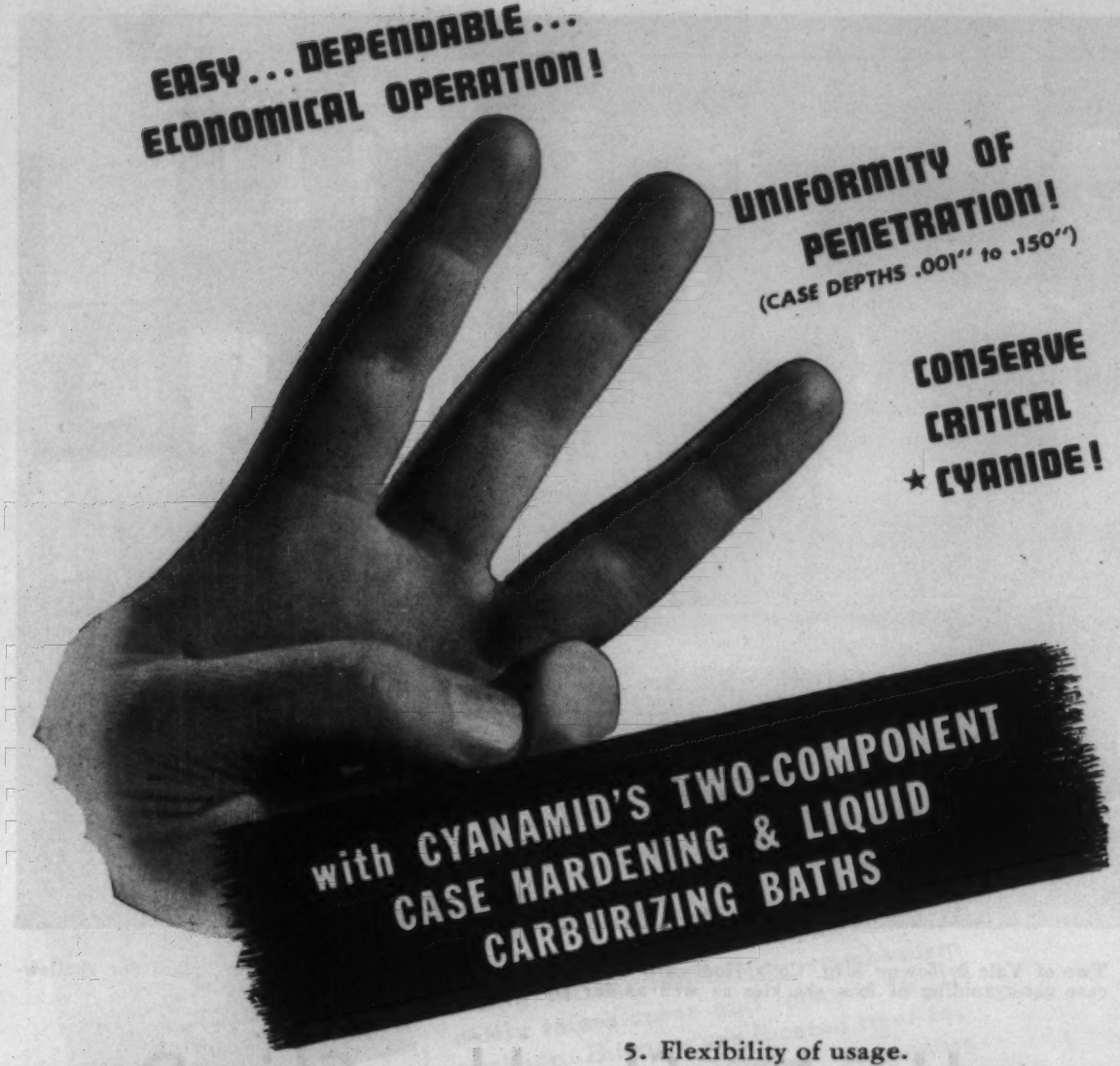
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES



AEROCARB*

—(Barium Base) Easy Washing

1. Usable temperature range of 1300° F.–1650° F.
2. Non-hygroscopic and non-corrosive.
3. Eutectoid case.
4. Low cyanide decomposition rate.
5. High fluidity—low drag-out losses.

AEROCARB DEEPCASE

—Maximum Case Depths

1. Operating temperature of 1700° F.–1750° F.
2. Penetration rate equal to gas carburizing.
3. Low cyanide loss.
4. Ease of control.

AEROCASE*—(Calcium Base)

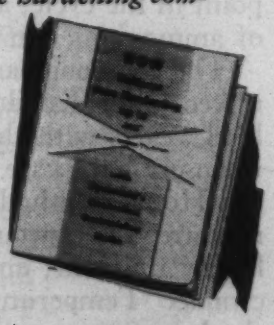
Superior Metallurgical Properties

1. Usable temperature range of 1250° F.–1650° F.
2. Density of 110 pounds per Cu. Ft. at 1500° F.
3. Maximum rate of case penetration.
4. Hypereutectoid case.

5. Flexibility of usage.
   (a) Maximum carburizing.
   (b) "Neutral" type hardening with same materials.
6. Ease of control.

★ Note: *Lower cyanide content required in Cyanamid activated carburizing baths as compared with the amount required in the non-activated types of cyanide case hardening compounds.*

An Important *New Reference* Text for the Metal Working Industry



A request on your company letterhead will bring you a copy of this new 32-page technical booklet containing the latest information on case hardening and liquid carburizing.

The facilities of our laboratories and the experience of our technical staff are available to assist in the solution of metal treating problems to which salt baths are applicable. We welcome an opportunity to discuss with you these problems.

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AMERICAN CYANAMID
& CHEMICAL CORPORATION
(A Unit of American Cyanamid Company)
30 ROCKEFELLER PLAZA · NEW YORK 20, N. Y.

tube. For Monel ferrules, induction heating is used for brazing; for brass or copper, oxyacetelene torches.

After brazing the ferrules are turned and faced in lathes with stellite tools. The tube is held in a collet chuck, with the extending end of the tube supported on a mandrel held in a tailstock chuck.

After bending, all tubes are cleaned, those filled with sand being first cleaned internally with a steel wire brush on a flexible shaft.

—H. Hodges, *Am. Machinist*, Vol. 87, Sept. 30, 1943, pp. 80-82.

Selenium Rectifiers

Condensed from "Iron and Steel Engineer"

The chemical element selenium, which may be classed as a semi-conductor of electricity, exists in three forms—the vitreous, which is almost an insulator; the alpha, which is crystalline, but has a high resistance; and the beta, which has a lower resistance. It also has a remarkable property, which contributes to the characteristics of the selenium rectifier—its specific electrical resistance decreases with temperature rise.

An essential property of all metal-plate rectifiers is that they possess asymmetric conductivity—that is, are better conductors with current flowing in one direction than in another. Rectification occurs at the contact surface of two dissimilar substances, usually referred to as a conductor and a semi-conductor.

In the selenium rectifier a metal base plate, usually iron, is the conductor, and a layer of selenium, .002 to .004 in. thick, is the semiconductor. The selenium is applied in vitreous form, but later processing converts all but a very thin layer to the beta form. A layer of metal alloy is then sprayed onto the selenium.

When a direct current is connected to this couple, with the sprayed metal side negative, a current will flow from the base plate to the sprayed layer. If the polarity is reversed, the flow takes place in the opposite direction, but to a very much smaller extent. The current rectification ratio is usually of the order of 100 to 1.

The ordinary commercial selenium rectifier consists of an assembly of rectifying plates mounted on an insulated bolt. This stack is suited for low current rectification, say 100 amperes or less. For d.c. supplies of thousands of amperes, as for electroplating, the number of discs required, at 15 amperes per disc, would make necessary a staggering number of connections.

To simplify the construction of parallel plate assemblies, a new design in the form of a strip or plate-type structure has been developed. It consists of a strip of steel to carry the combined currents of the individual rectifying elements, the discs being spot-welded to the strip. With 31 discs welded to the strip, and carrying 10 amperes each, the strip becomes in effect a 310-ampere unit.

Cooling arrangements may be of several

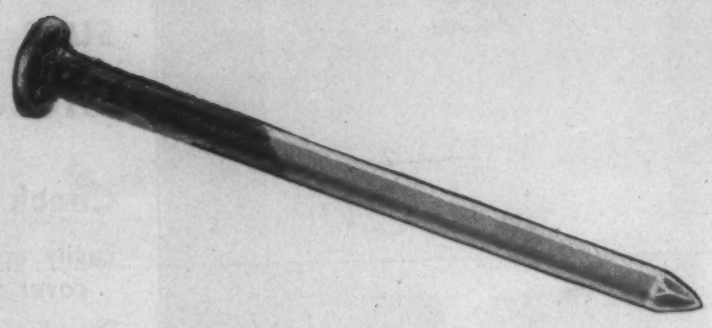
(Continued on page 166)

What to do about Rust?

Make this Test

Immerse any rusty nail in a small quantity of Cities Service Rust Remover. If badly rusted, allow to remain for several minutes. You can actually see the rust dissolve.

See the Results



Remove nail and wipe dry with cloth or tissue. Note the complete absence of rust and the way the original surface reappears.

CITIES SERVICE RUST REMOVER has been tested for four years throughout a small, highly industrialized area in the East, where it has earned a unique reputation for performance. RUST REMOVER is a clean, clear liquid, practically odorless, non-inflammable, easily applied, and harmless to handle by those not allergic to specific chemicals. It is fast-acting, and, although heating somewhat accelerates results, general application is recommended at normal temperature (60°-90°F.). RUST REMOVER is effective on chromium, copper, aluminum, steel and iron.

5 Big Advantages

1. Non-Inflammable
2. Harmless to Normal Skin
3. Makes Metals Chemically Clean
4. Removes Rust by Chemical Action
5. Free from Muriatic, Sulphuric, Nitric and Oxalic Acids or Cyanide.

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Gentlemen: I'd like to test RUST REMOVER on my own equipment FREE OF CHARGE. Send me details.

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Model P71—16" dia., 18" deep

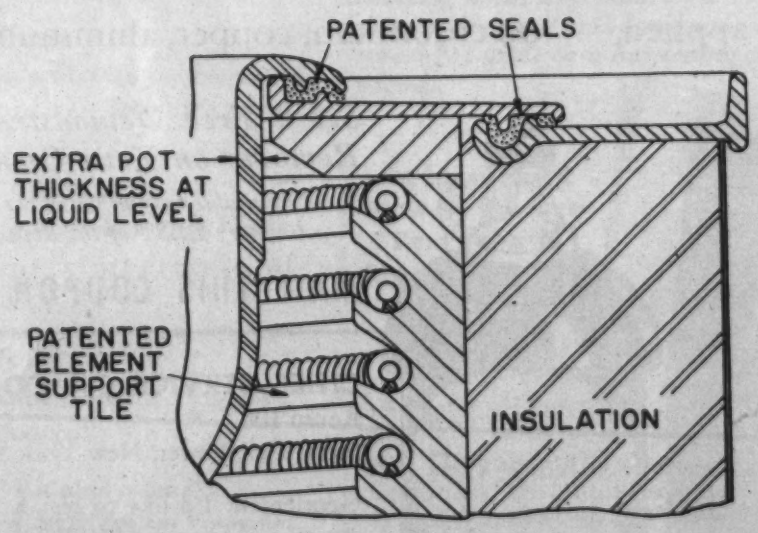
LOOK!

at several before you buy but be sure you get these features:

Check List:

- Easily operated insulated top cover
- Double flange pot
- Double flange supporting ring
- Double flange top ring
- Extra pot thickness at liquid level
- Element — one continuous helix extra heavy rod
- Positive element support in recessed refractory wall
- Lining 12¾ inches
- Two point heat control
- Time clock starting

For use with Lead Salt Cyanide



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Built in 8 Standard Sizes

American Electric Furnace Company

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Industrial Furnaces For All Purposes

kinds, but for plating applications, with exposure to corrosive vapors, best protection is obtained by operation in tanks, under transformer oil. A motor-driven blower may be used to direct an air blast over the tanks.

The a.c. supply to the rectifiers is changed from high to low voltage in the power transformers. Provision is also made for operation on either 220- or 440-volt systems. To vary the d.c. output of the rectifiers, induction regulators, taps on the main transformer primary circuit connected to tap switches, tapped auto-transformers with tap switches, and saturable core reactors are in general use. The object in all cases is to raise or lower the a.c. voltage to the rectifier.

—C. A. Kotterman & E. H. Pollack. *Iron & Steel Engineer*, Vol. 20, Oct. 1943, pp.73-81.

Furnace Brazing

Condensed from "Automotive & Aviation Industries"

Brazing has been adapted to mass production in recent years, such as in the manufacture of automotive parts, refrigerators, computing machines and various types of electrical equipment. The recent development by the Aluminum Co. of America of a method of brazing aluminum alloys has induced the aircraft industry to investigate brazing as a production process in airplane construction, where it will be limited largely to ferrous and aluminum alloys.

When applied to ferrous alloys, the advantages are as follows: 100% joint strength can be obtained in lap-type joints by merely increasing the amount of joint overlap; dissimilar metals and alloys can be joined satisfactorily; so can parts of different sizes and shapes; it may be possible to finish-machine and heat-treat parts to as high as 150,000 psi before joining, provided the brazing is done in a controlled-atmosphere furnace.

The disadvantages are: Production rates are lower than with flash welding and projection welding; for telescoped joints, machining to close tolerances is required; usually, post-brazing heat treatment is needed if strengths higher than the normalized strength of the parent metal are required.

But aluminum alloys offer a larger field of usefulness than ferrous alloys. So far the process is limited to the work-hardening alloys and the precipitation-hardening alloys, with no satisfactory technique for the age-hardening alloys. When brazing is done in an uncontrolled atmosphere, a flux must be used.

The strength of joints with present available brazing alloys is a function of the joint thickness, strength of the parent metal and the brazing alloy. There is an optimum joint thickness at which joint strengths can be obtained that are considerably greater than the strength of the brazing material, it being believed that some alloying of the parent metal and brazing alloy occurs by diffusion.

Joint strength falls off rapidly as its

Farquhar

FOR POST WAR PLANNING

Farquhar Hydraulic Presses are today affecting the shape of things to come in metals and alloys with pressures up to 7200 tons. Take powder metallurgy, for example, where smooth application of power and precision control are required for pressing larger pieces with speed and uniformity.

Years of building hydraulic presses for many industries give Farquhar a head start on your powder pressing needs. When your post-war processes call for hydraulic presses . . . powder metallurgy or any other industry . . . think of Farquhar.

Farquhar can also implement your new production with many types of Special Machinery. At your disposal are skilled Farquhar mechanics and workmen in well equipped shops: pattern making, foundry, boiler, welding, machine and assembly. Write Farquhar for details.

- HYDRAULIC PRESSES
- MATERIAL HANDLING CONVEYORS
- SPECIAL MACHINERY

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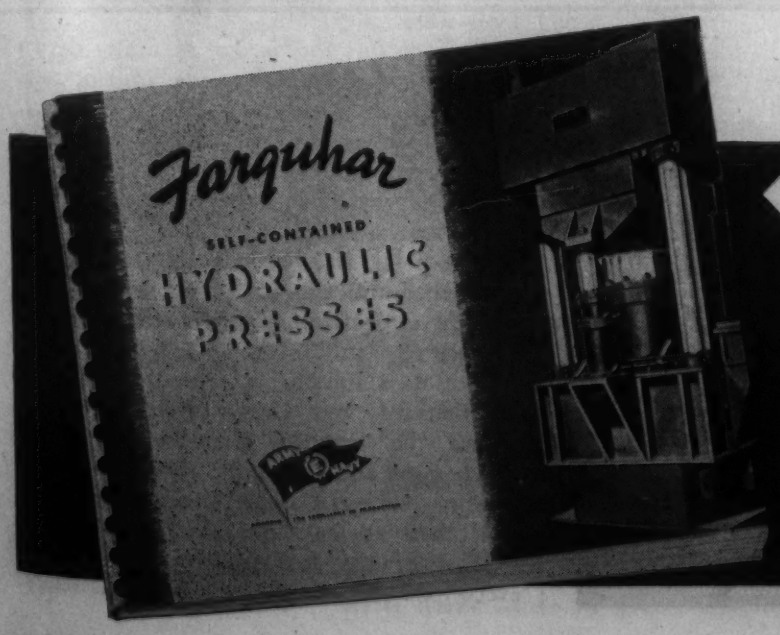

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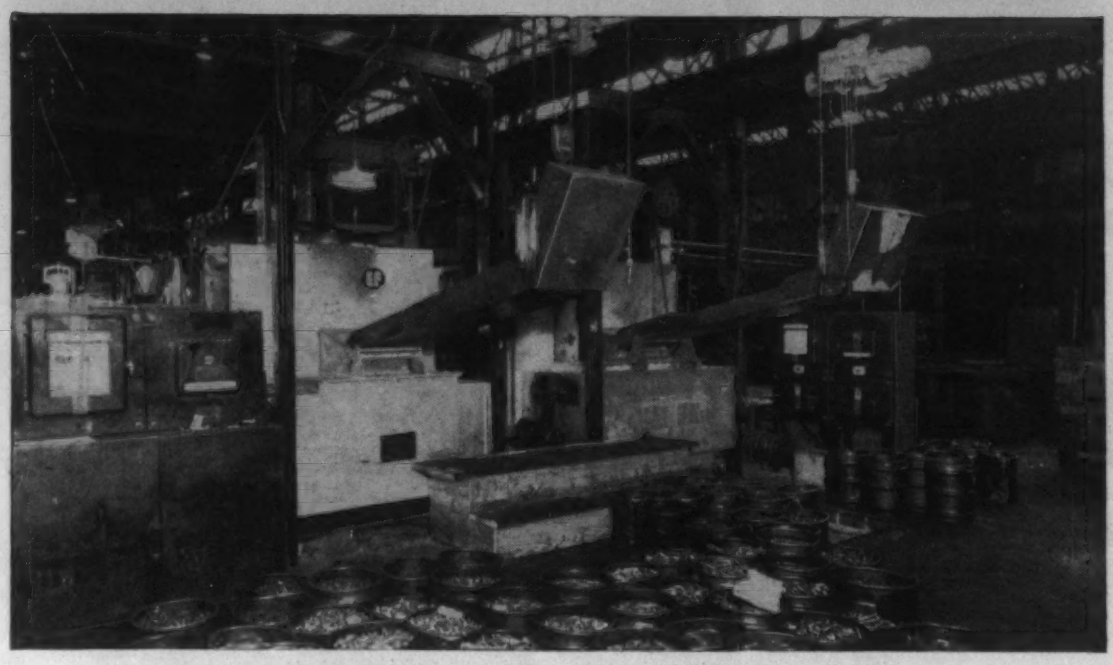
For Every Industrial Heat Treating Process



E F Continuous Chain Belt Conveyor Type Furnaces

FOR SCALE-FREE HARDENING

Bolts, Springs, Gears, Bearing Parts

and Miscellaneous Other Parts and Products

-300 to 1700 lbs. per Hour

The above E F gas fired furnace installation is one of several similar installations we have made for scale-free hardening bolts. E F Continuous Chain Belt Conveyor Type Furnaces are handling all kinds of products ranging in sizes from small springs and machine gun cartridge clips up to large crawler links for tanks and tractors. Hundreds of these furnaces are in operation.

The material is loaded directly onto rugged heat resisting cast link belt conveyors. Without further attention, it is carried through the furnace, uniformly heated to the proper temperature and automatically discharged through a sealed chute to the quenching medium or directly from the furnace as desired. The chain belt conveyor returns within the furnace without cooling—no pans or trays are used in the furnace —100% net material.

These furnaces are built for oil, gas or electric heat in five standard sizes with capacities ranging from 300 to 1700 lbs. per hour. Larger or smaller sizes can also be furnished. They are also designed for using special protective atmospheres for scale-free heat treating and hardening without decarburization.

The hundreds of installations in operation, handling all kinds of material, have proven them the most satisfactory and dependable general purpose heat treating machines built for the uniform, economical, production heat treatment of miscellaneous small and medium sized parts and products.

The Chain Belt Conveyor Furnace is only one of the numerous types we build for various heat treating purposes. Tank armor castings, shell forgings, cartridge cases, bomb and gun parts, aircraft and aircraft engine parts, and many other allied products are being uniformly treated in outstanding production furnaces built by the Electric Furnace Company, Salem, Ohio. We specialize in designing and building production furnaces.

Send for circulars showing these and other types of E F Production Furnaces

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

thickness varies in either direction from the optimum, due to the inability of the molten brazing metal to penetrate where the opposing surfaces are too close to each other. This inability to wet the entire surface reduces the effective area, and thereby reduces the over-all joint strength. The decrease in joint strength above the optimum thickness is due to a decrease in alloying effect.

Control of Thickness

The essential control of joint thickness can be accomplished in two ways: (1) Holding the parts at a constant distance from each other, and (2) clamping the parts together with a constant force. Thickness of many joints can be controlled by machining mating parts to close tolerances. Tack-welded joints or special locating fixtures also may be used to constrain, with respect to each other, parts to be brazed.

Of course, with a tack-welded joint it is hard to maintain the desired separation of parts accurately and consistently, and even with accurate fixtures repeated heating to the temperature required for brazing may impair their accuracy.

If a sheet of brazing alloy is placed between two parts to be brazed, the system clamped together with a constant force and then heated to the brazing temperature, the thickness of the brazed joint will be some function of the clamping force. Thus, constant-force clamps are indicated.

A study of the production use of furnace brazing is now being carried on by the Production Research Group, since this branch of brazing would appear the most promising.

—H. D. Samuel, Jr. *Automotive & Aviation Ind.* Vol. 89, Sept. 15, 1943, pp. 28-29, 64.

Tool Design

Condensed from "The Iron Age"

A professional heat treater who daily hardens many different steels employing a variety of treatments guesses that not over 25% of all the tools started through the tool room reach the job and achieve maximum productivity and life. For high-speed cutting tools he sets the figure at less than 10%. Last year $400,000,000 worth of such tools were made.

Some of this loss is due to faulty design or the selection of the wrong kind of steel for the job. The greatest loss, however, is due to the fact that tools are sent to the commercial heat treating plants for hardening without a correct analysis of the steel used to make them.

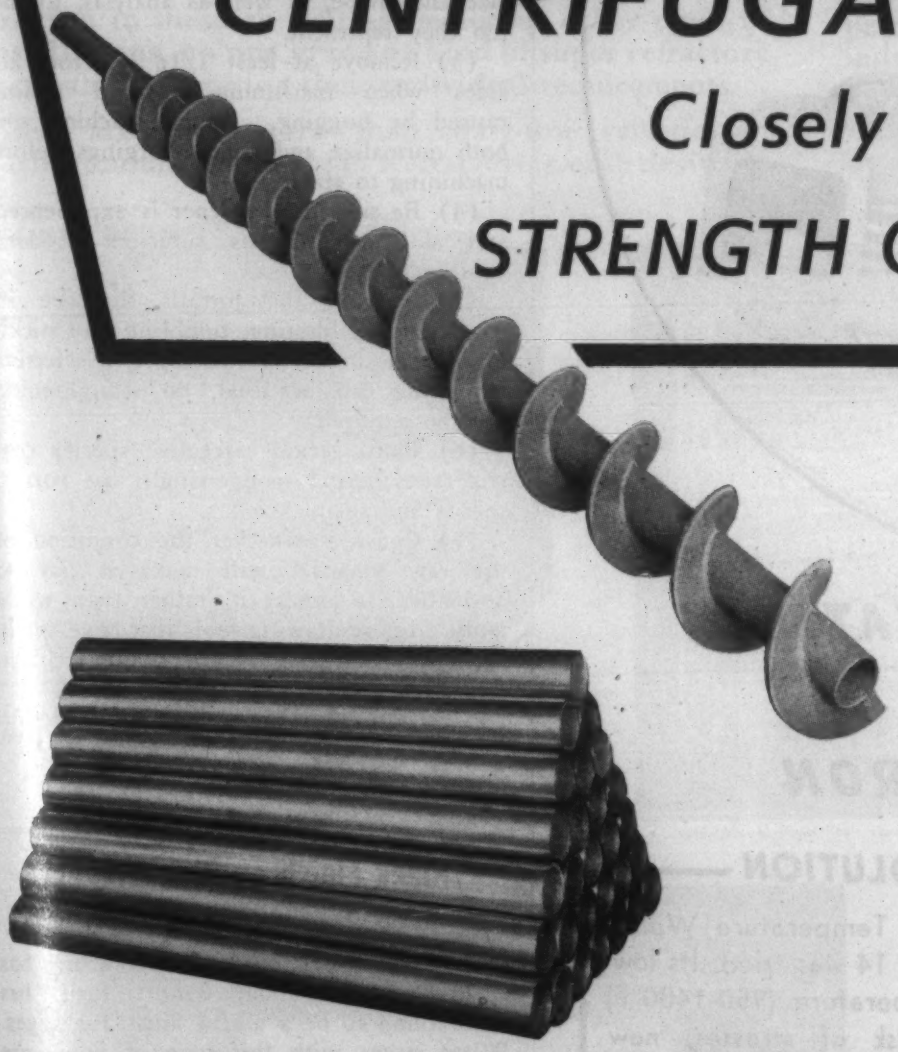
In a plant that hardens about 2 tons of high-speed and 20 tons of other tools each day, the information given is either missing or incorrect in 10 or 15% of the jobs. Where it is missing it means delay only, but that may cost lives. Where it is incorrect, the treatment is ineffective, has to be changed and the tools, if usable at all, are not efficient. Some firms seldom err, and others are constant offenders.

Most of the loss is preventable. For every tool and job there is one satisfactory

DURASPUN CENTRIFUGAL CASTINGS

CENTRIFUGAL CASTINGS

Closely Approach the STRENGTH OF FORGED STEEL



Besides closely approaching the strength of a hot-forged or rolled steel, DURASPUN Centrifugal Castings of chrome-iron or chrome-nickel, have other superior qualities in contrast with static castings. The metal is more uniform, denser and stronger—the structure is very fine grain, with fewer gas pockets and blowholes.

DURASPUN Centrifugal Castings may be produced in almost any shape—tubular or odd shapes are equally practical—the only *"must"* being a straight hole running through the center. In tubes, you get *true concentricity of diameters; uniform wall thicknesses; exceptional straightness.*

Consult our metallurgists on the profitable advantages you will gain by shifting from static to centrifugal castings.

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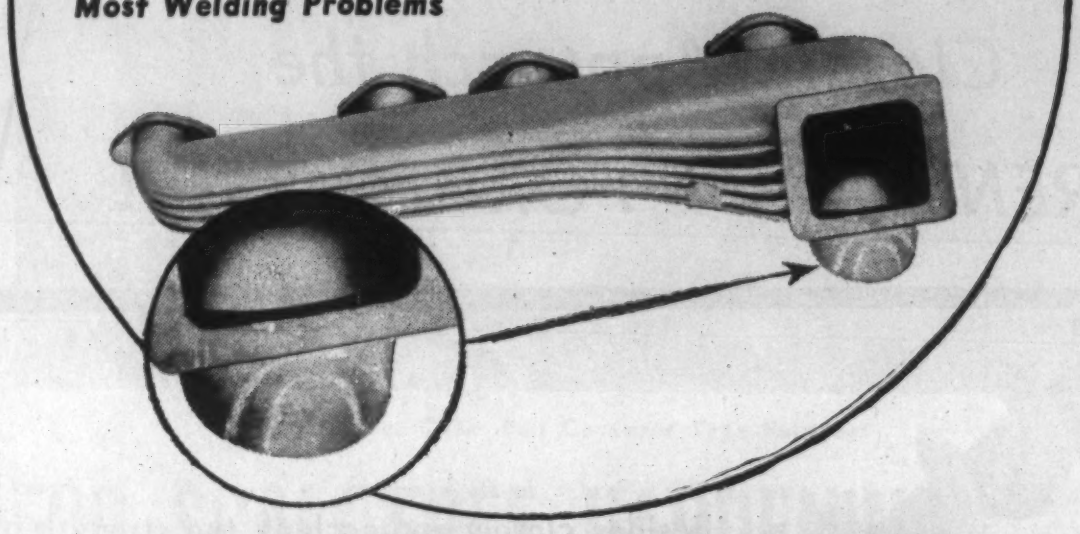
Castolin Eutectic

EUTECTIC*
(Means Lowest Binding Alloy)
LOW TEMPERATURE
WELDING

. . . The Answer to
Most Welding Problems



NO GENERAL PREHEATING
REQUIRED FOR
WELDING CAST IRON

PROBLEM

How to repair this cast iron exhaust with a color matching, heat resistant weld? With high temperature, fusion welding there was great risk of stresses, new cracks, and distortion even in the hands of the most skillful welder. Bronze brazing could not be used since the job requires a perfect color match.

SOLUTION

Eutectic Low Temperature Welding Alloy No. 14 was tried. Its low binding temperature (950-1400°F) eliminated risk of stresses, new cracks, and distortion. Many jobs require only slight local preheat • Weld has high heat resistance • Easily machinable • Perfectly color matching.

EUTECTIC LOW TEMPERATURE WELDING ALLOY RODS FOR CAST IRON

Alloy No.	Purpose	Binds at °F	Tensile Strength, Lbs. p.s.i.	Machinable
15	Filling cracks, defects	354° - 600°	1,140 (pressure)	Yes
14	High strength joining	950° - 1400°	48,000	Yes
16	Joining cast iron to steel	1300° - 1600°	117,000	Yes
24B	Cast iron not subject to stresses		38,500	Yes
24	Cast iron subject to stresses		20-30,000	Yes

For oxy-acetylene: Eutectic Nos. 14, 15, 16. For AC-DC Metallic Arc: Eutectic Nos. 24, 24B.
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Tells How Eutectic Can Help You!
Contains vital facts on design simplification • Joining dissimilar metals and gauges • Reclaiming delicate castings • Salvaging scarce tools • etc.

*Reg. U. S. Pat. Off.

EUTECTIC
WELDING ALLOYS COMPANY
Originators of the Low Temperature Welding Process
40 WORTH STREET, NEW YORK, 13, N.Y.

method. To ensure its use, the following points should be noted:

(1) Design the tools to withstand the hardening treatment, and choose steels that will produce the physicals required when treated.

(2) Choose the right treatment, and inform the hardener fully and correctly as to the kind of steel to use. In case-hardening tell the depth desired and whether to leave the job soft or hard. Also tell the use or purpose of the tool or part and supply test pieces bearing resemblance in size and shape, as well as analysis, to the job they represent.

(3) Remove at least 1/16 in. from all sides when machining. Avoid strains caused by hogging. Rough machine and both normalize and anneal forgings before machining to size.

(4) Be sure the hardener is experienced and skilled, and has sufficient modern equipment.

(5) Avoid the pitfalls that lie in straightening, blasting, tumbling and pickling delicate tools. For example, if selective hardening can be used, no straightening may be required.

(6) Finish grind carefully; specify correct rakes; grind soon enough; use correct speeds and feeds.

(7) Consider whether the condition of the raw material will make it pay to normalize or anneal it, rather than waste tools. Try re-drawing tools that have work-hardened, and do not overlook reclamation.

—A. S. Eves, *Iron Age*, Vol. 152, Sept. 23, 1943, pp. 45, 130.

Black Finish on Steel Gages

Condensed from "Industrial Finishing"

An oiled black oxide finish, which has a thickness of about 0.0001 inch, has been found to be a useful finish for gages. When gages with this type of finish are employed, a bright spot will appear after considerable use. This is a visual indication of a reduction in gage size of about 0.001 in. per surface. The gage can then be given another black oxide treatment and used again, this procedure being repeated until the allowable tolerance of the gage has been reached. The above system has given particularly good results with thread and plug gages.

In addition to the visual evidence of wear noted above, several other advantages are claimed. These are: (1) Stain and corrosion from handling are prevented. (2) Burrs and nicks on the threads of blacked thread gages are visible to the naked eye, whereas with unblacked gages examination with a magnifying glass is necessary to see such defects. (3) Tampering with the gages is made evident. (4) The oxide surface reduces friction, resulting in less binding and less possibility of damaging the softer metals being gaged.

The blackening process is not expensive to apply, and once the necessary equipment is installed it can be used to advantage to finish many other steel parts and tools.

—A. F. Brooks, *Industrial Finishing*, Vol. 19, No. 10, 1943, pp. 22-23.

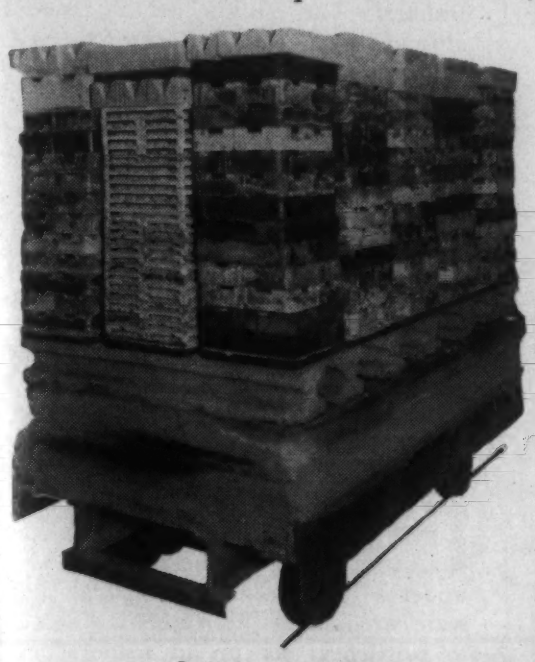
It is practical experience that counts in applying Super Refractories

IN firing steatite—roasting corrosive ores—treating metal parts—reducing and refining non-ferrous metals, radically different conditions are encountered. Yet, in these diverse operations there is a common need—the need for super refractories such as produced by Carborundum. With the variable conditions existing in these as well as numerous other types of installations, no one grade or kind of super refractory is capable of meeting their individual requirements.

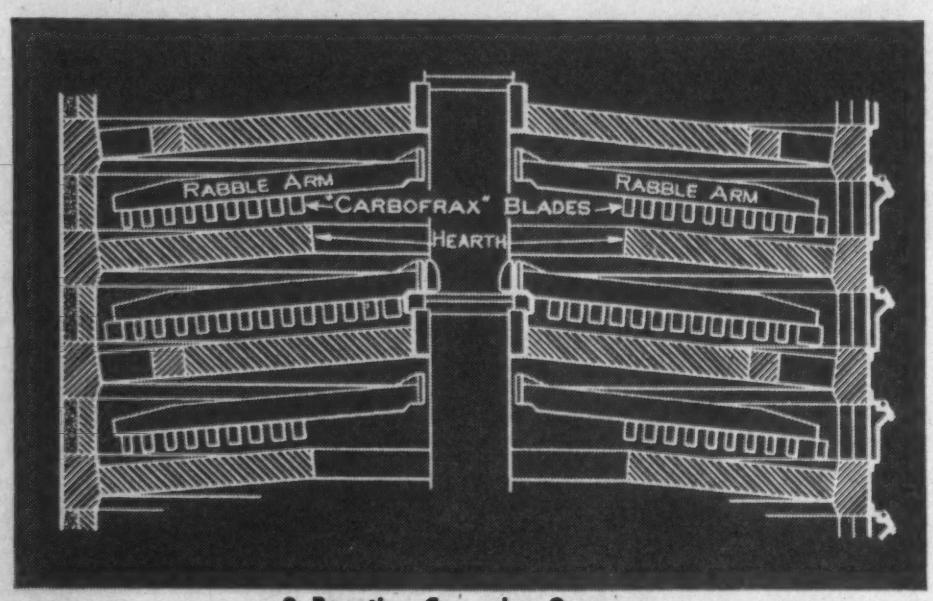
There are now more than sixty-five varieties of Carborundum Brand Super Refractories, each designed to withstand specific service needs. But of equal importance is the ability of our engineering staff to select the right super refractory for the purpose and apply it to a given installation.

Our comprehensive understanding of refractory problems—gained from years of practical and technical experience—has proved exceptionally valuable to war industry plants. It will be equally advantageous to operators of new and improved processes for the post war era.

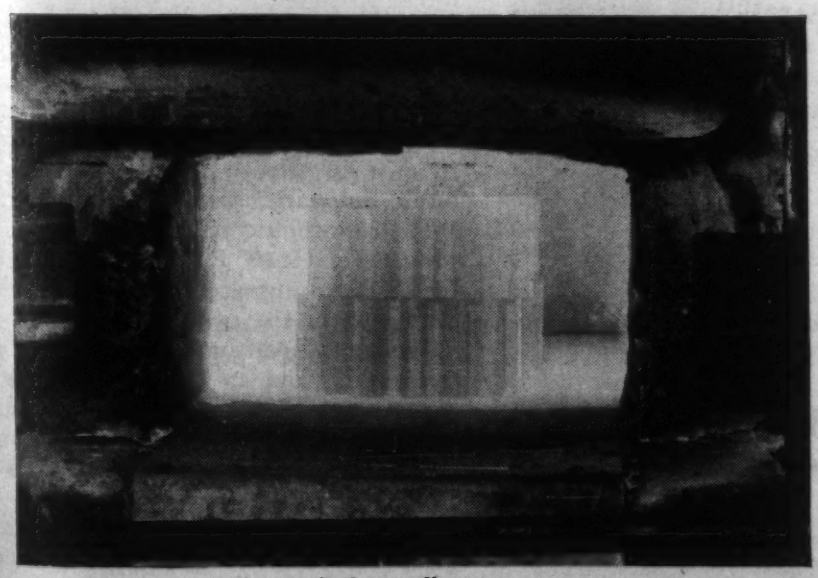
Let us consult with you on your refractory problems.



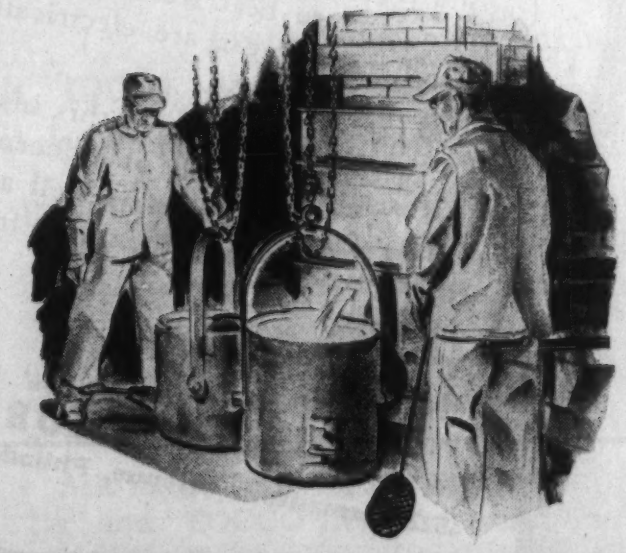
1 Firing Steatite



2 Roasting Corrosive Ores



3 Annealing



4 Reducing and Refining Non-ferrous Metals

Every hour this war is shortened will save $12,000,000. The lives it will save are priceless. Let's get it over with—quickly!

REFRACTORY CARBORUNDUM PRODUCTS

Refractory Division, **THE CARBORUNDUM COMPANY,** *Perth Amboy, N. J.*

REG. U. S. PAT. OFF.

MANUFACTURERS OF GRINDING WHEELS, COATED ABRASIVES, SUPER REFRACTORIES, HEATING ELEMENTS

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(Carborundum, Carbofrax, Alfrax and Mullfrax are registered trade-marks of and indicate manufacture by The Carborundum Company)

HOW TO STREAMLINE

HEAT-TREATING PRODUCTION

Constructed for the heat-treatment of steel castings, this battery of gas-fired furnaces illustrates the degree of engineering perfection to be expected when R-S Engineers are called into consultation.

Three of the R-S Car Hearth Furnaces are direct fired for high temperatures while the fourth (second from the left) is convection heated for low temperature heat treating. Furnace doors, cars and transfer car are electrically operated from central stations.

All those who have seen this installation say that it is a fine example of modern streamlined heat-treating production as well as an efficient method of obtaining the most from available manpower.

Inquiries are invited.

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Hydrogen Brittleness in Steel Wire

Condensed from "Wire and Wire Products"

Hydrogen embrittlement may have its origin in a number of different conditions as well as from pickling in acid, which gave the older term, "acid brittleness." The basic cause is the absorption of hydrogen in the crystal structure of the metal.

The action of acid on metal releases atoms of hydrogen gas which may enter the metal while in the atomic state or may combine together to form molecules. Molecular hydrogen is not soluble in the metal. Pickling in nitric acid does not cause brittleness, as nitric is an oxidizing acid.

Electroplating from cyanide solutions is one of the chief potential sources of trouble. The electrochemical action liberates hydrogen from the cyanide, especially at high current densities. Also, there is the factor of cleaning the parts. Other protective coatings present the same problem. Corrosion or rusting may bring embrittlement. The flux used in soldering or brazing operations may be the cause.

Practical Effects

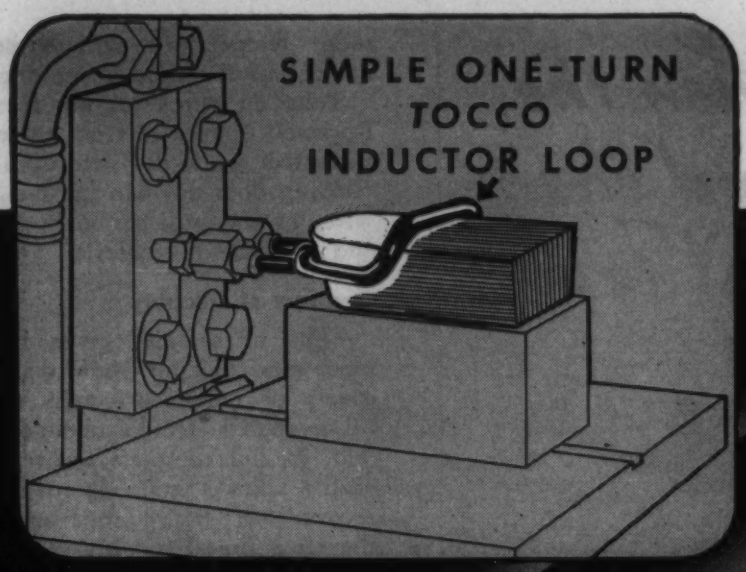
Embrittlement is reflected in the physical properties of the wire. Tensile strength and ductility measurements are lowered. Ability to stand cold working or cold bending is lessened. In wire drawing, ductility will not withstand drafting. In cold rolling strip, checks and cracks will occur. Any cold working operation is difficult, and a peculiar type of fracture sometimes occurs after some definite but not long time under a load as little as 1/10 of the ultimate strength of the material. This is due to brittleness set up in manufacture and trapped under the coating.

In the bend tests reported here, No. 12 (.1055 in.) wire was used with arbors of various sizes from 1 to 4½ times the wire size. This gave a direct index of brittleness, since such wire should bend around its own diameter as an arbor without fracture. Sulphuric acid, 8% at 140° F. and 50% hydrochloric acid, both at room temperature and 170° F., were used for pickling. There appeared to be little if any difference in the two acids.

From a comparison of treatments at room temperature and at 170° F., it seems that the greatest amount of damage occurs at room temperature. At the higher temperature the hydrogen probably combines into molecules and escapes.

The index of brittleness for heat treated wires was found to be at least two points higher than that of cold worked wires. Damage to the cold drawn wires does not occur until an appreciable time later than damage to the heat treated. With tempered wires at room temperature there is no damage for some time, but then it increases steadily. On the cold drawn wires, the damage occurs later, is less serious and tends to remain constant. At 170° F. damage occurs rapidly with tempered wires and a little less rapidly with cold worked. The amount of damage holds fairly constant.

A short dip up to 3 or 4 minutes at room temperature will not cause any appreciable damage, but the same dip at a higher temperature will. Over-pickling at



A Hot Tip...

Braze carbide tool tips with this "TOCCO JR. 7½"... the new low-cost "heat-treating department" with a multitude of uses.

● Simply place the prepared shank and tip in the TOCCO inductor, press a button and in 10 to 30 seconds the tool tip becomes red hot . . . so quickly the tool often can be removed with the bare hand before the heat has time to reach the far end!

Timing is automatic, accurate to a split second.

All sides of brazed joint are heated simultaneously, uniformly.

Speedy heating affords high rate of output.

Three sizes of inductor loops (which can be made readily in your shop from standard copper tubing) cover the average range of tool sizes.

Clean, cool and compact, the "TOCCO JR." is ideal for the tool room or production line.

By simple change of work fixture, the TOCCO machine can be adapted to brazing, hardening, annealing or heating for forming of a wide range of parts . . . for war or peacetime production.

Ask for bulletins on the New "TOCCO JR. 7½" and "TOCCO JR. 15" . . . small, low-cost units ideal for brazing of tool tips and scores of other heat-treating applications.

THE OHIO CRANKSHAFT COMPANY • Cleveland 1, Ohio

TOCCO

HARDENING..BRAZING

ANNEALING..HEATING

★

THE easy way leads to waste of materials, time and money, disappointing service—ultimately means loss of reputation as good workmen.

The right way is usually the harder way, but it is axiomatic that service will be gratifyingly good, that products will be efficient.

The right way is our way, the only way we know to do a job. The "Four Factors Way" spells reputation, trust and confidence in ability to create dependable products.

The "Four Factors Way"

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2. Accurate and thorough foundry practice
3. The proper chemical analysis
4. Metallurgy

Our carburizing boxes, trays, retorts, fixtures, lead, salt and cyanide pots, furnace parts, skid rails, roller rails, shoes, beams and all types of heat and corrosion resisting castings, as well as special designs for special jobs, have the "Four Factors" built in.

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room temperature will cause increasing damage as the time is prolonged.

Tests on wires varying from 52 to 30 Rockwell C, pickled from 15 sec. to 2 min., show that while one- and even two-minute-pickling does not damage the 30 Rockwell wire, 15 sec. will seriously damage the 49 and 52 Rockwell material.

Recovery of Ductility

Tests of samples given recovery treatment after pickling show that complete recovery of reduction-in-area value in 1065 oil tempered steel is obtained in 1 hr. at 300° F., but complete recovery of bending ability takes 3 hrs. At room temperature, recovery of both properties takes about the same time—168 hrs.

High temperature baking cannot be used where there is the possibility of damage to the plating. Loss in tensile strength is only partially recovered even when bending ability is fully restored.

—Rodman R. Tatnall. *Wire & Wire Products*, Vol. 18, Oct. 1943, pp. 607-611, 614.

Quenching Oils

Condensed from an American Society for Metals Paper

A study was made of the properties of eight commercial quenching oils, both as received and after considerable quenching had been carried out in them. Flash and fire characteristics are important mainly from a safety standpoint. Specific gravity and viscosity are relatively unimportant, *per se*, but more viscous oils have a higher drag-out loss than more fluid oils.

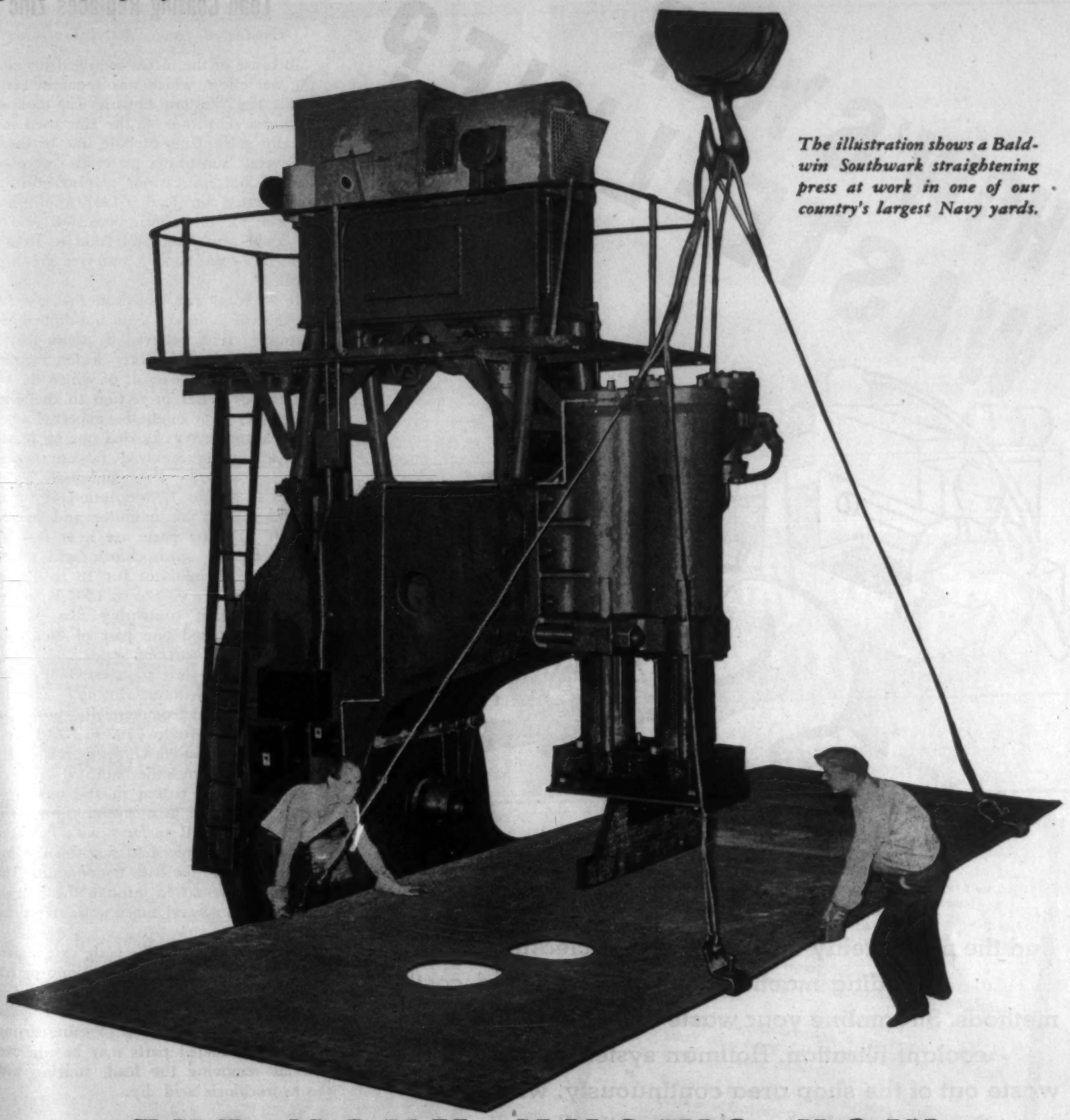
The evaporation losses were determined at 150°F., 200°F., and 250°F., as these characteristics have some bearing on life if not on performance. Quenching rates were determined for all oils at various oil temperatures.

There are negligible differences in the quenching rates of new and used oils. For each oil, there is an optimum oil temperature to give maximum cooling rates at the nose of the S curve. Higher or lower oil temperatures retard the cooling rate in this critical range. Warm oil has the desirable effect of giving slower cooling rates in the region of the martensite transformation, and, therefore, tends to inhibit the formation of cracks.

The origin of the oil (mineral, animal, or mixed) had no effect on quenching rates. The slight differences in the quenching rates of "light" and "heavy" oils can be compensated for by adjusting the oil temperature. The greatest variation in quenching rate developed by the oils tested is only a minor factor in terms of steel hardenability.

In view of the lack of metallurgical differences among the oils, the selection of a quenching oil should be primarily controlled by consideration of two factors: (1) a flash and fire point high enough to prevent undue fire hazard; and (2) cost per pound of steel quenched under normal operating conditions.

—E. K. Spring, P. T. Lansdale & C. W. Alexander. A. S. M. Preprint No. 4, Oct. 1943 meeting, 15 pp.



The illustration shows a Baldwin Southwark straightening press at work in one of our country's largest Navy yards.

THE NAVY KNOWS HOW

Choosing the proper equipment to achieve a desirable result is not an easy task. The U. S. Navy knows how, as a glorious history indicates. It is tribute to Baldwin Southwark presses to find the Navy placing many of these presses in Navy yards throughout the country.

Baldwin Southwark shipyard equipment includes bending rolls, joggling presses, plate planers and keel benders.

Baldwin Southwark also produces hydraulic press equipment for all types of industries. The Baldwin Locomotive Works, Baldwin Southwark Div., Philadelphia, Pennsylvania, U. S. A.

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End the mess, delay and confusion of cleaning grinding machine sumps by old and costly methods. Streamline your waste-line with Hoffman coolant filtration. Hoffman systems carry all the waste out of the shop area continuously, with the used coolant—and automatically collect it in dry form at one place for convenient disposal.

The constant flow of standardized clean coolant also improves quality, saves abrasive.

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Lead Coating Replaces Zinc

Condensed from "Metal Finishing"

Because of the increasing need for zinc in the war effort, which was apparent early in 1941, the Western Electric Co. took steps to find a substitute for the zinc used in the hot-dip galvanizing of pole line hardware.

Several substitute materials were considered, but for various reasons effort was concentrated on lead. Lead coatings are resistant to atmospheric corrosion, and will no doubt give long protection to iron and steel if a continuous, pore-free coating is applied.

It is recognized, however, that pin holes are usually present in hot-dipped lead coatings. It is believed by some that pin holes in lead are quickly sealed by corrosion products, as a result of which the coating affords better protection to the underlying steel than might be expected.

In the process as carried out at Western Electric, oil is removed by any suitable cleaning method. Rust and scale are removed in a 6 to 12% solution of sulfuric acid containing an inhibitor and operated at 160° F. The parts are next immersed in a 5 to 10% hydrochloric acid solution containing an inhibitor for 10 to 15 min. at a temperature of 120 to 150° F., then in a flux solution containing five parts of zinc chloride and one part of ammonium chloride in six parts of water.

The work is then transferred directly to the lead bath without rinsing. The lead bath consists of commercially pure lead, maintained at 690 to 710° F. A layer of fused zinc ammonium chloride flux, at least ⅛ in. thick, covers the bath.

The parts are passed in and out of the bath through the flux several times to insure contact of all surfaces with flux, then submerged or allowed to float on the bath until they reach the bath temperature. They are then again passed through the flux and into the bath several times until completely coated.

After removal from the bath, excess metal is immediately removed by shaking or centrifuging, and the parts are quenched in hot water. They should be removed quickly from the hot water to expedite drying Incompletely-coated parts may be run over without removing the lead, starting with the hydrochloric acid dip.

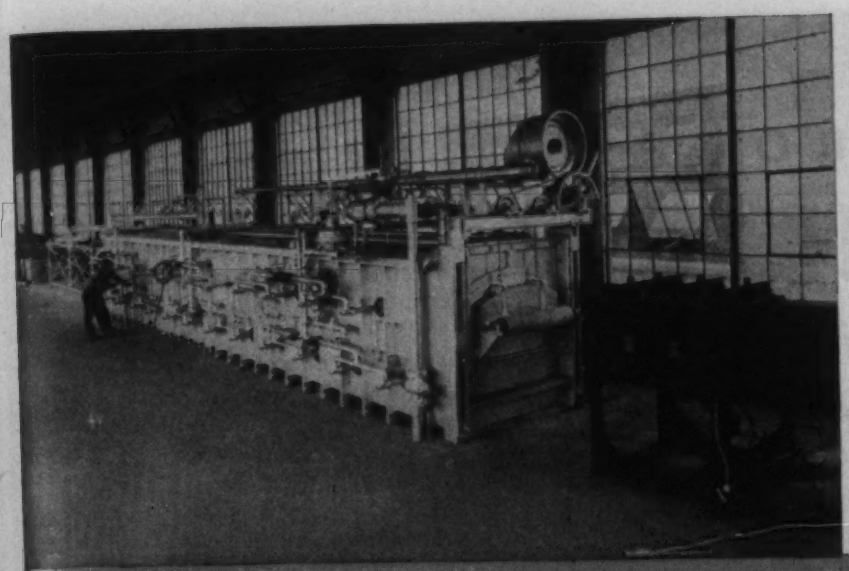
Improves with Use

The lead bath does not give satisfactory results until after it has been in operation several days. From then on it improves with use. Lack of time has prevented a study of the reason for this improvement.

The weight of lead coating varies between 30 and 200 mg. per sq. in. (corresponding to approximately 0.00015 to 0.001 in. thickness). The type of parts, the bath temperature, and the degree of centrifuging or shaking are the determining factors in coating weight.

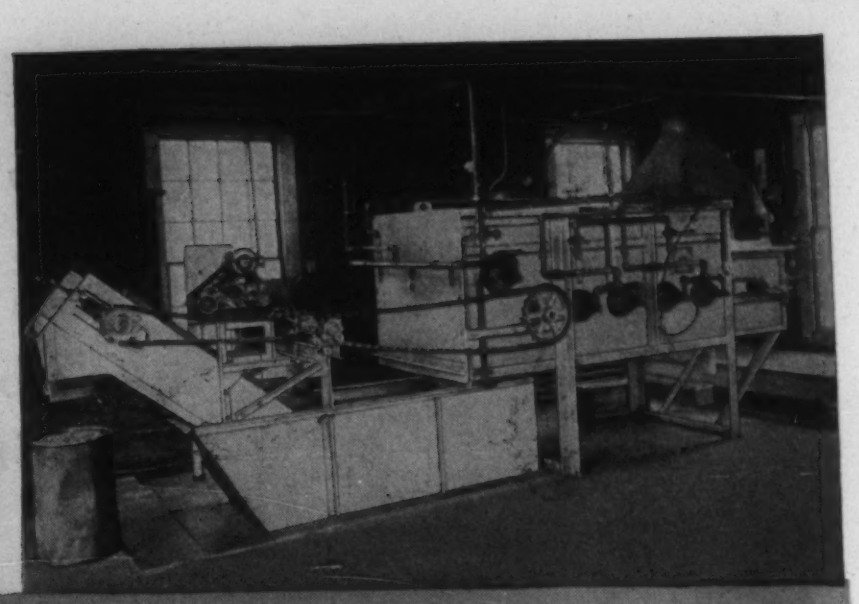
The same equipment used for hot galvanizing is suitable for lead dipping. Zinc should be ladled from the pot as completely as possible and replaced with lead. On heating the lead to the zinc bath temperature, the residual zinc floats to the top and can be skimmed off.

Frequent skimming for several days will



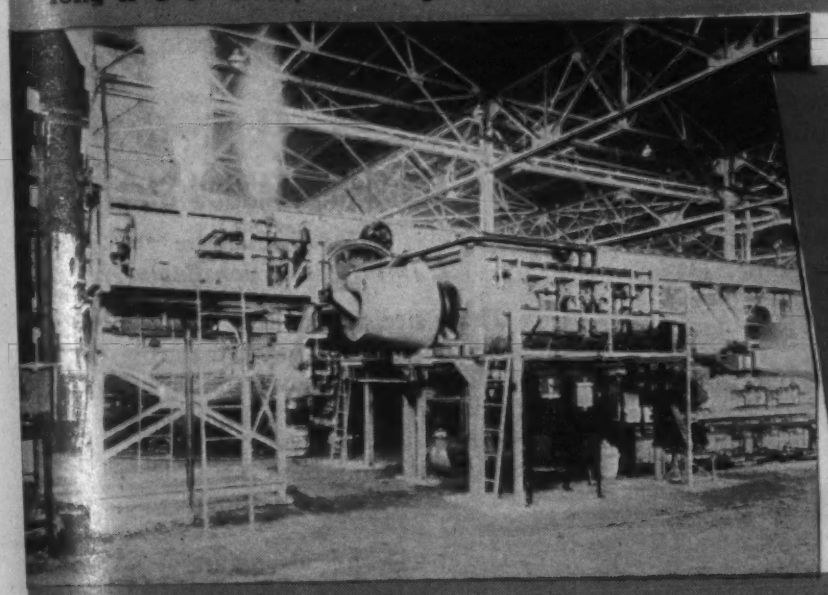
ANNEALING STAINLESS STEEL STRIP

Recent installation of a continuous catenary type furnace handling 3300 lbs. of strip per hour; 36 ft. long x 4' 6" wide; butane gas fired.



HARDENING STEEL SPRINGS

One of several types of fully automatic hardening furnaces, discharging work into a conveyor quench tank; gas fired.



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A completely automatic set-up of a washing machine, gas fired revolving retort annealing furnace and rotary drum pickling machine synchronized for continuous feed and discharge of 3000 lbs. per hour.

Let Heating Quality Dictate Your Furnace Selection

What should you expect of the furnace you need? Faster production? Yes. Economical heating? Yes, that too. But most important of all must be the certainty that your product is of the quality you expected from the heat treating operation. Translate that into furnace specifications and you get

1. Proper heat input, accurately controlled as to temperature, furnace atmosphere and time.
2. Complete thorough exposure of every part of every piece of work to uniform heating and cooling.
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Fifty years of developing thousands of furnaces from their crude beginnings to today's modern precision heating units are your sound assurance that a Rockwell Furnace, whether a small batch furnace or complete conveyor type precleaning, heat treating and quenching equipment, is engineered for the job your process requires.

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PYROFLEX

CORROSION-PROOF TANKS

for pickling, plating, etc.

Showing Pyroflex material being heated and applied to steel tank.

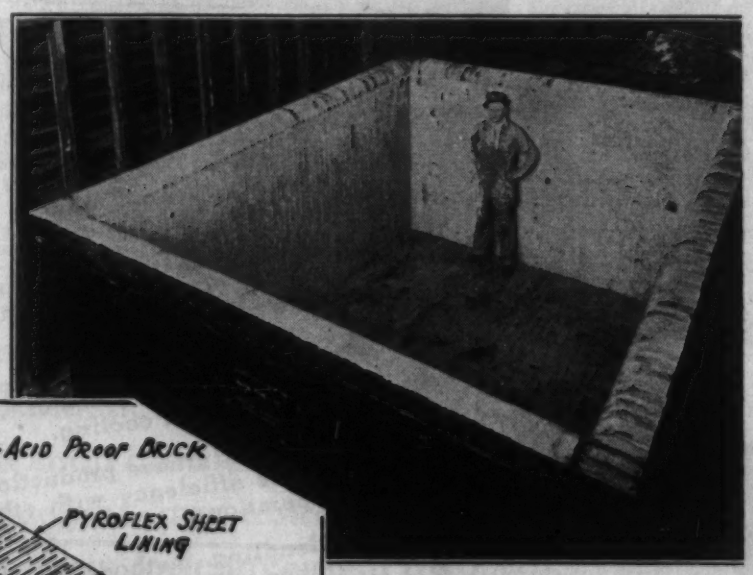
ILLUSTRATED here are types of Pyroflex constructed tanks made by the Knight organization for corrosive service. Pyroflex itself is an acid resisting thermoplastic which is applied in sheet form as a protective lining.

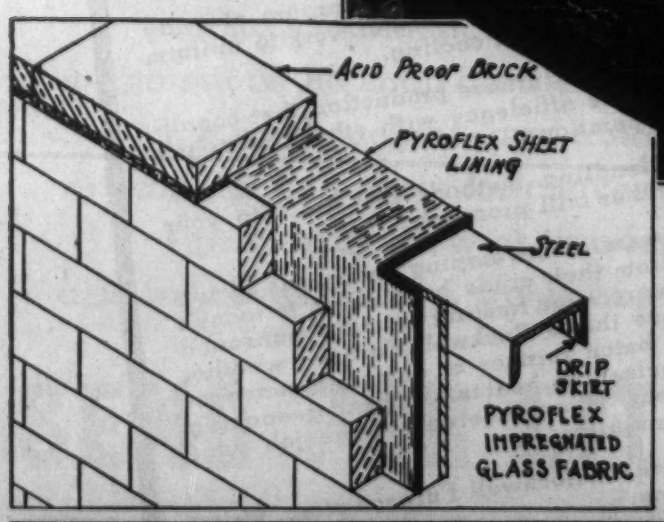
In combination with the proper brick or tile sheathing and appropriate cement, Pyroflex provides a permanently acid and leak-proof lining. It bonds strongly to any smooth, clean surface. It can be applied to ceramic, glass, steel, concrete or wood structures.

Pyroflex lining can be installed with Knight supervision on existing equipment or as an integral part of a complete unit, such as a refining, plating or pickling tank. Large areas such as floors or settling basins can be made corrosion-proof with Pyroflex construction.

Knight engineers welcome your inquiry on Pyroflex. Be sure to give them as complete data as possible regarding the character and purpose for which it is to be used.

Maurice A. Knight
97 Kelly Ave.
Akron 9, Ohio





Typical Open Top Chemical Processing Tank

Pyroflex and Fused-on Brick Lining

Left: Typical Pyroflex construction detail

KNIGHT-WARE
CHEMICAL EQUIPMENT
MAURICE A. KNIGHT
ACID PROOF CHEMICAL STONEWARE

remove all but a few tenths of a per cent of zinc, and this appears to alloy with the lead. The bath should not be used for dipping during the skimming period.

Lead dipping has several advantages over hot galvanizing. For example, there are no dross losses, the lower operating temperatures lengthen the equipment life, and flux skimming and replacement are required less frequently than with zinc.

The Western Electric Co. is applying lead coatings to over 60% of its pole line hardware, and although time has not permitted life tests to be made under all conditions, the coating is considered a satisfactory substitute for zinc.

In the early work, experiments on numerous lead alloys were carried out. Lead alloys containing about 3% Sb gave smooth coatings having good covering properties.

—W. Yonkman. *Metal Finishing*, Vol. 41, 1943, pp. 560-561.

Machining Leaded Steels

Condensed from "J. Instn. Production Engineers"

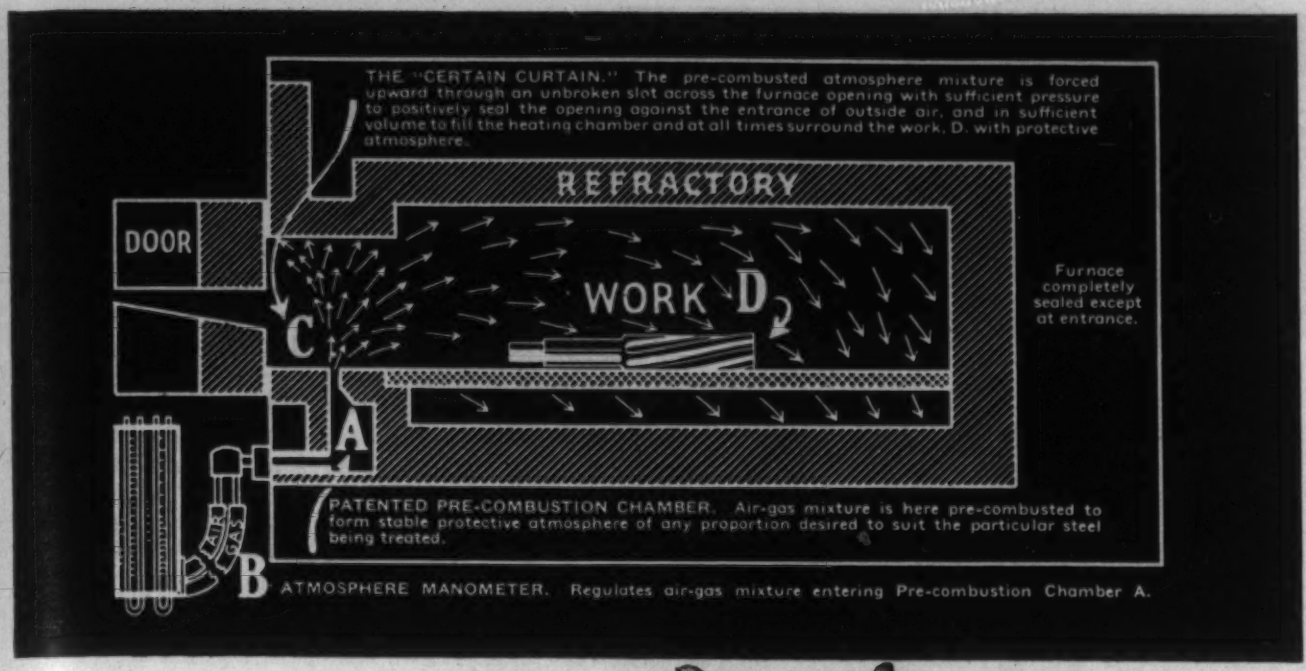
Those steels containing 0.15 to 0.30% Pb which have been produced during the past three years have shown the following characteristics: Mechanical properties, at room temperature, the same as lead-free steels; considerably improved machinability; economical to use; can be produced in a wide range of properties.

The machining advantages are: a lowering of the energy required to produce a chip, a cooler chip and, therefore, a cooler tool, and shorter chips. These advantages may be utilized to increase tool life, or to give higher speeds or higher feeds, or both.

While drilling and sawing tests indicate an advantage between 25 and 40% for leaded steels, these figures cannot be exactly correlated with machinability index or with results of lathe work. They do follow the same laws in general as non-leaded steels, so that machinability index may be used as a basis for comparison. If feeds be increased rather than cutting speeds, they (and, therefore, production) may be increased 50 to 80%.

Tests of steels in general showed that increasing the cutting speed greatly decreased the tool life. Changing the chip thickness by altering the feed has a material effect upon tool life, while the effect of altering depth of cut (chip width) is relatively small. Chip thickness can be altered by changing the angle subtended between the cutting edge of the turning tool and the axis of the material being cut, again affecting tool life. The introduction of a nose radius also reduced average chip thickness.

The following observations are worthy of emphasis as far as applied to turning tools: (a) Select the heaviest feed that can be tolerated, with due regard to finish and thrust on spindle; (b) where possible, use a tool with side cutting angle and nose



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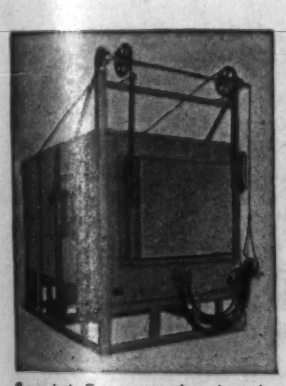
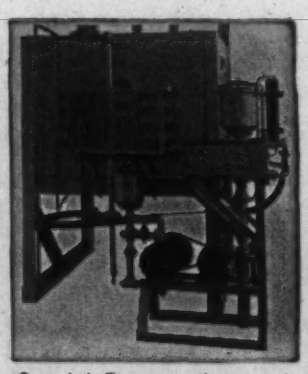
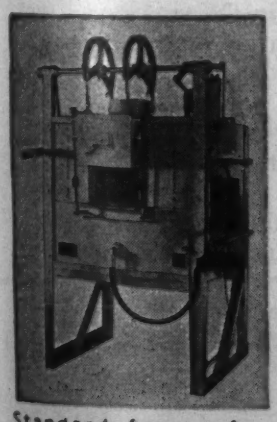


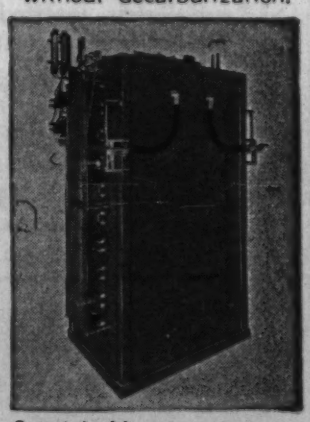
Special Furnace for hardening large dies



Special Furnace for hardening MOLY STEELS without decarburization.



Standard furnace for hardening high speed steel tools.



Special Vertical furnace for hardening large broaches up to 7 feet.

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If you have furnaces that you feel are holding up production and losing money because outworn or outmoded, by all means call in one of our men. You will, we believe, find that amazing gains are indicated when you have the latest and finest equipment. Remember, we not only offer you the finest available controlled-atmosphere furnaces, but in addition we have a streamlined, fast-moving engineering-advisory-installation group who are accomplishing near miracles. They "live with" a job . . . see that the customer's production flow is protected . . . iron out the kinks and carefully instruct operators. All that we have learned in 18 years of precision atmosphere control is at work assuring the speed and success of your installation. Today we have the opportunity to schedule certain types for early delivery. Get in touch NOW.

"CERTAIN CURTAIN" FURNACES FOR—

- High Speed Preheating
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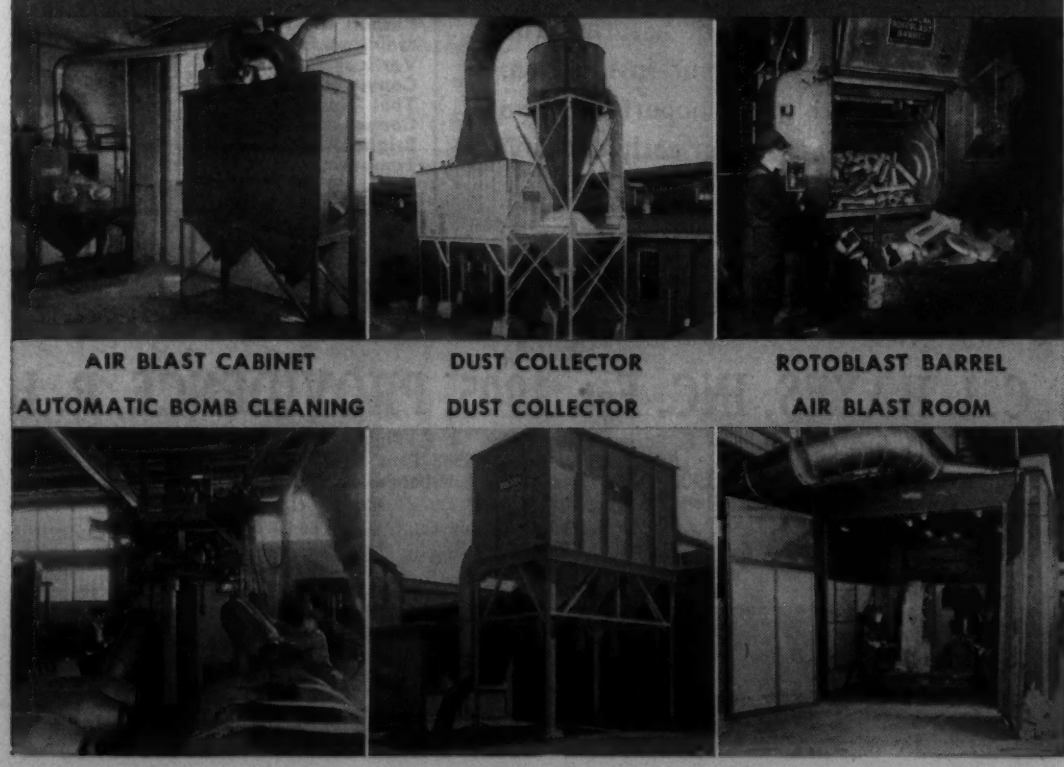


radius; (c) select a cutting speed to give a tool life that will maintain machine efficiency; (d) apply adequate supply of coolant; (e) chatter is reported to be minimized by avoiding chip width greater than 25 times chip thickness, and using a nose radius of one-half depth of cut; (f) effective top rake using H. S. steel should be 10 to 15° for steels ordinarily machined in automatics; (g) tools should be jig ground, smooth finished, sharp edged, and have consistently correct angles.

For the leaded steels, conversions from pressure constant differences to machinability index have shown increases of the order of 25 to 45% in the index over non-leaded steels. Results of 50 different reports upon various machining operations with leaded steels showed about 40% increased production, with the range from 20 to 100%. They do not require specialized technique for their manipulation, it was stated.

—*J. Instn. Prod. Engrs.*, Vol. 22, June 1943, pp. 211-229.

Improved War Tooling

Condensed from "Tool Engineer"

When the National Cash Register Co., Dayton, undertook to manufacture the magazine for the 20-mm. Oerlikon anti-aircraft gun, production practice at first was based on previously-tested methods. More efficient methods and changes in product design and specifications have resulted in conservation of men, materials and machines, and better products.

Side plates for the drum-shaped magazine have a spiral groove that receives a spiral-formed steel strip. Originally, the groove was milled with an end mill, holes were drilled through the groove, and the spiral strip inserted in the groove and spot welded from beneath the plate through the holes. Now the groove is stamped into the plate, using a coining die. A hydraulic punch-press produces the entire output. The strip is then copper brazed to the plate. This has eliminated 239 special groove cutting-machines and saved 24½ tons of metal and 65,000 man-hours per month.

The slot in the mouthpiece forging, originally milled, is flame cut, using a cam feed for control. The scrap cut-out is heated, reforged to size, and machined to produce several ratchet rawls per blank. Three punch-presses are used to make this part, previously made from a square-edge stock on six milling-machines.

The mouthpiece is then broached on several surfaces, using two broaching machines. Then four holes are drilled and two lugs hollow milled on a special machine. Resultant savings were six 4-spindle drill presses, 20 milling-machines, and 41,000 man-hours per month.

The cover plate was originally machined from solid steel. Then it was cast from bronze, saving 45% machining time. With scarcity of bronze, it was made from malle-

*Phos-Copper** FOR *Brazing*

SAVES TIME · MATERIALS · MAKES SOUNDER JOINTS

AND IS *Immediately Available!*

Industry, today, is brazing many parts which were formerly drawn, cast, machined or forged—for brazing is producing important savings not only in men, materials and machines, but also in money and minutes.

For example, if you are now machining parts out of brass, bronze or copper, in many cases you can do the job faster and better by changing over to stampings that can be assembled and brazed. Or, if you are now brazing nonferrous metal parts with high temperature, hard-to-handle alloys or expensive silver solders, specify Westinghouse Phos-Copper and you will reduce rejects, speed output and cut manufacturing costs.

Brazing with Phos-Copper is *fast*. It flows free and smooth at 1382° F., cutting application and assembly time to the bone. And in many applications, Phos-Copper is successfully replacing hard-to-get tin solders.

With any brazing method, you will save time, money, materials, and get sounder, tighter joints with Phos-Copper, and . . . it's immediately available. Ask your Westinghouse Office for a sample for an on-the-job test.

NEW PHOS-COPPER BOOKLET. Get your copy of the new Westinghouse brazing bulletin B-3201. It explains ways to braze, how to make good brazes, proper joint design, and gives complete application photographs and details about Phos-Copper. Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., Dept. 7-N. J-91035

WAYS TO BRAZE WITH PHOS-COPPER

GAS BRAZING—with oxyacetylene torch . . . most widely used method.

"TONG" BRAZING—also called incandescent carbon brazing . . . saves time and materials.

ELECTRIC FURNACE BRAZING—for mass production brazing of a wide variety of parts.

DIP BRAZING—in either metal or chemical bath, heated by gas or electricity.

Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

PHOS-COPPER

IMMEDIATE DELIVERY ON ALL SIZES AND SHAPES OF PHOS-COPPER

ROD: Ideal for face-feeding—particularly where torches are used. Sizes: $\frac{1}{16}$" to $\frac{1}{4}$"—36" long. Small sizes are excellent for joining small parts.

RIBBON: Used especially for inserts. Comes .015" thick by 1.25" wide in various lengths. Approximately 16 feet per pound.

SPECIAL SHAPES: Popular for "tong" and furnace brazing. Preplacement of Phos-Copper makes mass production brazing possible and economical. Rings, strips, thin ribbon, diameters smaller than $\frac{1}{16}$", etc., can be supplied for special applications.

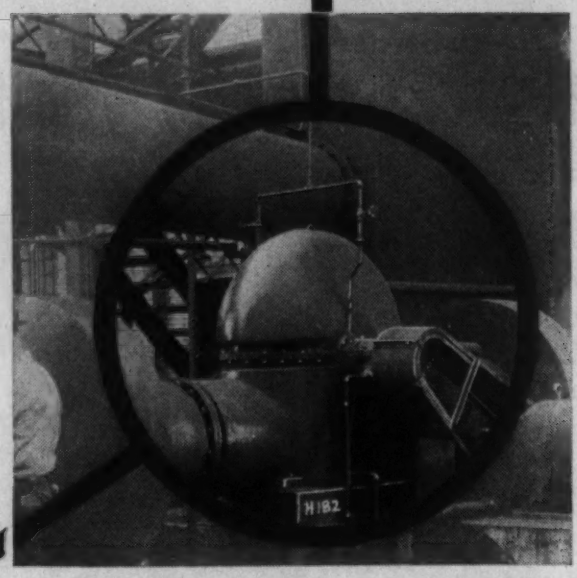
*Phos-Copper is an alloy of phosphorus and copper used for brazing copper, brass or bronze joints.

"ENGINEERED-TO-THE-JOB"
- assures permanent satisfaction

Among engineers and plant executives,. who appreciate the importance of engineered-to-the-job construction, you will find a high respect for the performance of Roots-Connersville centrifugal units.

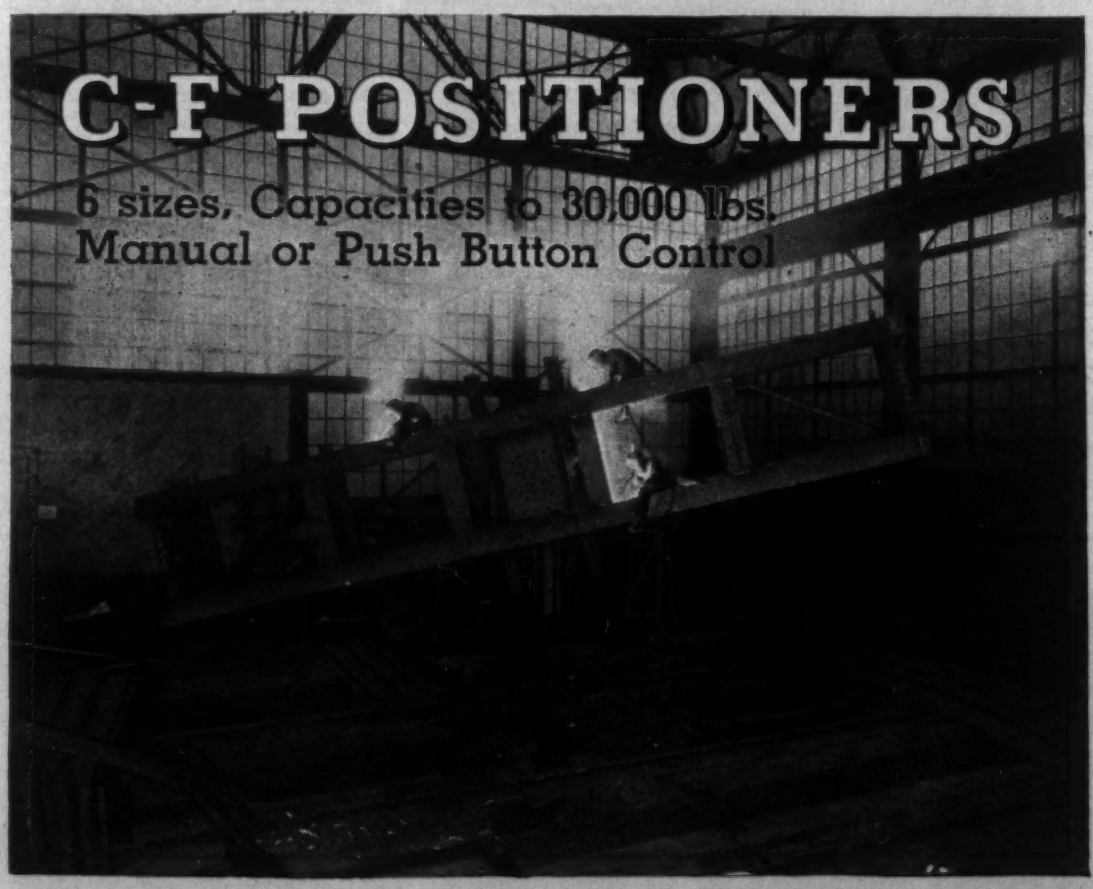
Our outstanding record of designing and producing air and gas handling equipment that gives permanent satisfaction is the result of long experience and superior facilities—plus a full knowledge of what engineers want and what steel mill conditions demand. Write for literature.

ROOTS-CONNERSVILLE BLOWER CORP.
401 Superior Ave., Connersville, Ind.



An "R-C" double suction centrifugal hot vapor blower installed in the coke plant of a large steel company. Capacity 480,000 c.f.h.; 3000 r.p.m.; 3 lb. gauge discharge.

Roots CONNERSVILLE SINCE 1854 — Centrifugal EXHAUSTERS and BLOWERS



The extra strength built into C-F Positioners enables them to withstand the extreme side thrusts and torsional strains met in positioning cumbersome or unbalanced loads—Coupled with the C-F *pedestal mounting* and adjustable height features, this extra strength increases the range of work handled, makes each C-F Positioner the most versatile in its capacity. *You can do more work with C-F Positioners.*

WRITE FOR BULLETIN WP-22

CULLEN-FRIESTEDT CO., 1314 S. Kilbourn Ave., Chicago 23, U.S.A.

able iron. It is now fabricated from steel, by using punch-presses and resistance welding. On a similar part, fabrication saved 9.4 lbs. of bronze per part.

Fabricating the spring axis instead of turning from a solid steel bar saved 6650 man-hours and 16 screw-machines. The collar, with groove, is die cast on to the bar, using Zamak.

Extruded Gear

A small pinion gear, originally produced by hobbing, is made by extruding bar stock to form gear teeth and finishing on screw-machines. Savings included 1599 machine-hours per month and 6% of the original material.

The thimble-shaped 20-mm. fuse once required four separate operations. An indexing fixture was devised which counterbores, assembles, crimps and stamps, and automatically ejects the part. Savings were two special counterboring machines, two special assembling machines, six punch-presses, and 9,000 man-hours per month.

The pneumatic feed on a multiple-head drilling fixture has permitted loading and unloading work while the machine is in operation, and has resulted in less tool breakage.

The spring casing has an external flange at one end and an internal one at the other, and was originally turned down from heavy-walled tubing. Later, the tubing was cut by a double-action broaching die and the flanges brazed to the tubing. Now the tubing is flame cut to the proper size. Five old punch-presses and nine old lathes relieved 11 critical screw-machines and conserved more material than the part weighed, and 1575 man-hours per month.

The plunger body has two slots of unequal width which are punched pneumatically. The part is then drilled by two drills, and is deburred. All operations are performed by one operator, three parts always being in process. This group of fixtures has replaced four punch-presses, nine 2-spindle drills, and two burring heads.

Finishing operations on the stainless steel relay igniting charge housing required 17 single-spindle drill-presses and three milling-machines. A special machine was designed and two were built to perform all these operations.

—Jerome Wilford. *Tool Engineer*, Vol. 12, July 1943, pp. 76-82.

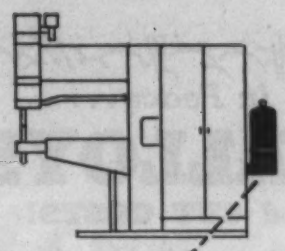
Electrostatic De-tearing

Condensed from "Industrial Finishing"

Many plants throughout the country are manufacturing steel shells of various sizes. These shells must be finished with a suitable protective coating. In the case of 75-mm. shells, a single coat of dip-applied and baked phenol-formaldehyde resin varnish meets the strict specifications of the Ordnance Department.

A cross-bar type conveyor is used with 10 shells suspended from each cross-bar. The clean shells are submerged in the dip-

SCIAKY



announces a significant achievement in the field of electro-magnetic stored energy resistance welding . . .

a d-c current interruptor — *without arc*

DYNATROL

PATENT PENDING

NO ROUTINE MAINTENANCE REQUIRED

ACCURATE CONTROL OF SECONDARY CIRCUIT DUE TO ABSENCE OF ARCING IN PRIMARY

INCREASED EFFICIENCY OF ELECTRO-MAGNETIC ENERGY SYSTEM — SHORTER CHARGING TIME

SPEED INCREASED 20% OVER MACHINES OPERATING ON CONTACTOR SYSTEM

THE SCIAKY DYNATROL provides the answer to contactor problems on electro-magnetic stored energy resistance welding equipment. This high-speed device performs the function of accurately interrupting the charging current to the reactor *without arc.*

The problem of interrupting a d.c. current in a highly reactive circuit has always been considered difficult because it is necessary to dissipate the electro-magnetic energy stored in the circuit in order to stop the flow of current. On former Sciaky machines, this was accomplished by a contactor unit, which together with an arc-blowing device, arc-laminating shields, etc., produced a highly accurate interruption of the charging current.

However, in industrial production, the continuous arcing finally results in a deterioration of the contact tips, requiring periodical maintenance and replacement. It was considered desirable to solve this problem in such a way that the same consistent welds be produced without any maintenance of the interrupting device. To this end, the DYNATROL was developed and was found to be not only a means of more accurate and efficient current interruption, but also, because of the shorter charging time, *actually increases operating speeds 20%.*

The DYNATROL is available on all Sciaky Stored Energy machines up to 50KW.

Descriptive bulletin 201-A ready soon. Write for your copy.

SCIAKY BROS.

Manufacturers of a Complete Line of
A.C and D.C Electric Resistance Welding Machines
4915 W. 67th Street, Chicago, 38, Illinois

In War, as in Peace...

CERRO ALLOYS

SAVE TIME and CUT COSTS!

CERROMATRIX (Melting Temp. 250°F.) For securing punch and die parts, anchoring machine parts without expensive drive fits, short run forming dies and other metal-working applications.

CERROBEND (Melting Temp. 158°F.) Used as a filler in bending thin-walled tubing to small radii. Easily removed in boiling water. Also used for aircraft assembly jigs, templates for forming dies and other purposes.

CERROSAFE (Melting Temp. 190°F.) Used to accurately proof-cast cavities such as molds, gun chambers, forging dies, etc., and for many similar applications.

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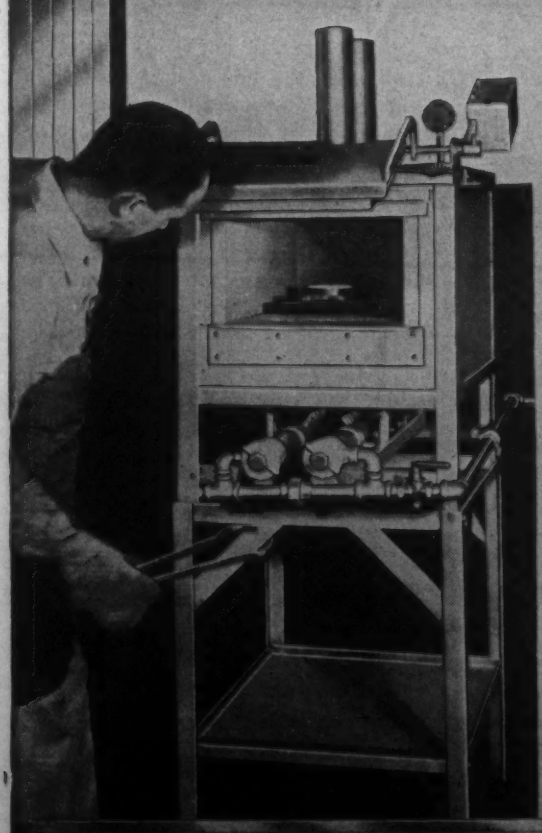
40 WALL STREET NEW YORK CITY

Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6″ x 8″ x 5½″, to No. 24, which is 12″ x 20″ x 8″ as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6″ x 12″ x 5″, is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½″ x 15″ x 2½″ high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.

113 Astor St., Newark, N. J.

tank at such an angle that no air pockets can form inside the shell case and emerge at an angle that allows varnish to drain from the flat top of the shell case. After leaving the dip-tank, the shells pass over a drain board where excess varnish flows off.

The special feature of the process is the next step after draining. This step, the "de-tearing" treatment, is what makes dip-coating practicable for this type of work. The drain-off points of the shells pass over electrodes that are charged to a high electrical potential of about 85,000 volts.

"Fatty edges" and "tears" are dispersed on passing over the electrodes. Up-draft ventilation carries solvent vapors away from the de-tearing unit. A second unit, located about 5 ft. beyond the first, removes any beads that may reform after the first de-tearing operation.

After leaving the second de-tearing unit, the shells are hung on another conveyor that carries them through a baking oven, after which they are packed for shipment.

The de-tearing power equipment is simple and the power consumption is low. In this installation the primary power source is 220 volts, 60 cycles, and it draws 3 amperes.

—H. L. Thomas, *Industrial Finishing*, Vol. 19, Sept. 1943, pp. 22-30.

Flash Welding in Aircraft

Condensed from an American Welding Society Paper

About five years ago the Douglas Company purchased its first flash welder, a 450-kva machine. It proved so satisfactory that a smaller machine was purchased and a research program instituted to develop a technique that would produce reliable results, and to determine resulting strength values.

Aircraft applications are largely alloy steel tubing, and manufacturers' recommendations were converted to apply to this. Width and thickness govern total loss, of which about one-fifth is upset travel. Fatigue and tensile tests showed failure at a considerable distance from the weld, or occasionally failure in the weld at the strength of the unwelded samples. The flash-welded parts were, therefore, accepted at 100% of strength of the parent metal, whereas gas or arc welds are frequently considered to have about 80% efficiency.

Flash-welded parts are checked for alignment, appearance, material loss, and weld quality, and test coupons, pieces of tubing joined by a weld, are tested to destruction in tension. As production increased, variation in dimensions of the unwelded parts was noticed, and deviations from the ideal machine settings were required to compensate. A reliable method of inspection was required. Magnetic and X-ray methods were tried, but proved accurate only when the weld could be machined free of flash

ARC WELDING HIGH LIGHTS

MUREX ELECTRODES were among the first of the "hot rods" available to the welding industry. Introduced thirteen years ago by Metal & Thermit, these heavy, all-mineral coated electrodes for downhand welding were sensational because of the high currents at which they operated and the excellent, X-ray clean weld metal they produced.

Fabricators of pressure vessels, machine frames, bases and other heavy units were quick to appreciate the advantages of electrodes of this type, and to put them to use in reducing welding costs and improving the quality of welding.

Today, concerns who were among the original users of downhand Murex Electrodes are the leading producers of war materials and are making use of the high speed welding techniques which these "hot rods" make possible to turn out tanks, gun mounts, bombs and other armaments at an unprecedented rate.

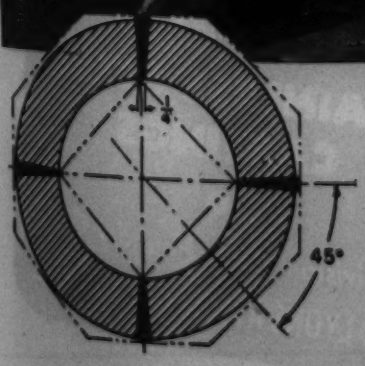
Illustrated are several typical applications—past and present—of this kind of welding.

The Murex line, of course, also includes electrodes for all-position work, for use with a.c. equipment, for welding alloy steels and for hard surfacing. Write for the Murex war time catalog.

Pressure vessels, made by Black, Sivalls & Bryson Inc. of Oklahoma City, for low temperature service in the oil refining industry, are fabricated with Murex nickel steel electrodes, chosen because of their fast downhand characteristics and high physical properties. Such pressure vessels are welded as rapidly as mild steel.

In the early days of coal mining every operation was performed by human labor and animal power. Today mechanization dominates every activity. Typical of the heavy equipment, which must stand hard and constant usage, is this Goodman Shaker Conveyor. Photograph shows welding a shovel trough of a duckbill loading head with Murex Electrodes, selected because of the strength and ductility of the deposited metal.

At the plant of the Eljer Co., Salem, Ohio, men who had become skilled in making plumbing fixtures are now turning out 1000-pound bomb casings. Photograph shows arc welding first pass on upper and lower portions of an aerial bomb. The use of downhand Murex Electrodes assures X-ray clean welds of good penetration and excellent ductilities.



This huge column, one of four for a 3300-ton hydraulic press, was fabricated from four segments by arc welding because of the inability of steel foundries to produce a cast column with a 14" bored hole straight enough to allow a 13" rod to pass through it. Murex downhand electrodes were used, starting with 5/32" rods and changing to 5/16" size as the width of the joint increased.

MUREX

ARC WELDING ELECTRODES

•

METAL & THERMIT CORPORATION

120 Broadway, New York 5, N. Y.

ALBANY • CHICAGO • PITTSBURGH

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Specialists in welding for nearly forty years. Manufacturers of Murex Electrodes for arc welding, and of Thermit for repair and fabrication of heavy parts.

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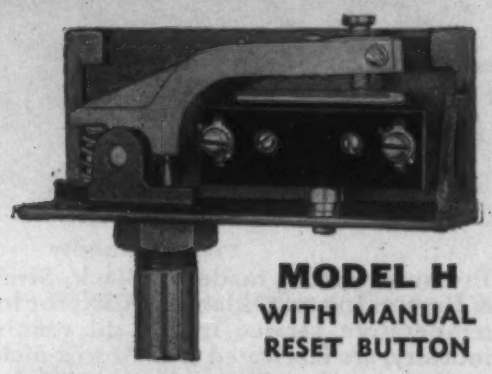
TEMPERATURE
LIMIT SWITCHES

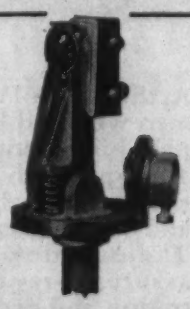


MODEL H
WITH MANUAL RESET BUTTON

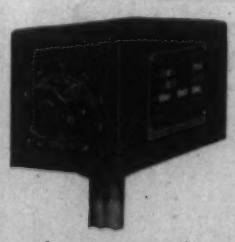
Improved High Temperature Safety Switch with Manual Reset Button. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell — with single pole double throw switch . . . breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside of case.

- **Accurate, Rugged, Dependable**
- **Corrosion and heat resisting tube**
- **Dial Pointer for easy setting**
- **Locking screw locks temperature setting**
- **Terminal plate has large screw terminals**
- **Snap-action Micro-Switch eliminates contact troubles**
- **Range 0-1400°F. Adjustable range 200-300°F**
- **Dimensions—5⅛" x 1¾" x 3"**

MODEL V-I



For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high)



MODEL D

Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½x2¾x2¾").

Instruments also Built to Specifications

Send for Informative Bulletin

BURLING INSTRUMENT CO.
Springfield Ave. at Livingston St.
Newark, N. J.

material, often impossible inside tubular assemblies.

Proofloading all parts to which a load can be applied was a fairly satisfactory test. Sometimes a bending or torsion test was used, although a tensile test at 60% of the ultimate strength of a sound weld was most frequent.

Since flash weld production is fairly high, there must be frequent setup changes. If provision for fast, accurate adjustment of the machine dies could be incorporated into the machine design, perhaps by a horizontal, a vertical, and a swivel adjustment of the entire stationary platen, 50% of setup time could be saved. Precision back stops could save another 25%.

At the present time, most aircraft flash-welding applications are S.A.E. X-4130 steel. Although normalizing of flash-welded assemblies is occasionally necessary, considerable time is saved by eliminating unnecessary heat treatment with its resultant warpage.

The procedure used for setting up a new flash weld job is: (1) Test coupons are procured; (2) the machine is set to give the total travel required, of which from 20 to 35% will be upset travel; (3) the closed position of the clamping dies will be as near as possible, to maintain alignment; (4) speed and current are adjusted for steady vigorous flashing; (5) for some parts, particularly those with wall heavier than 1/16 in., beveling the end of one part may be beneficial; and (6) trial welds are made and tested until satisfactory, when the setup is recorded and production begins.

—C. B. Smith, Am. Welding Soc. Paper, Oct. 1943 meeting, 8 pages.

Pressed Pistons

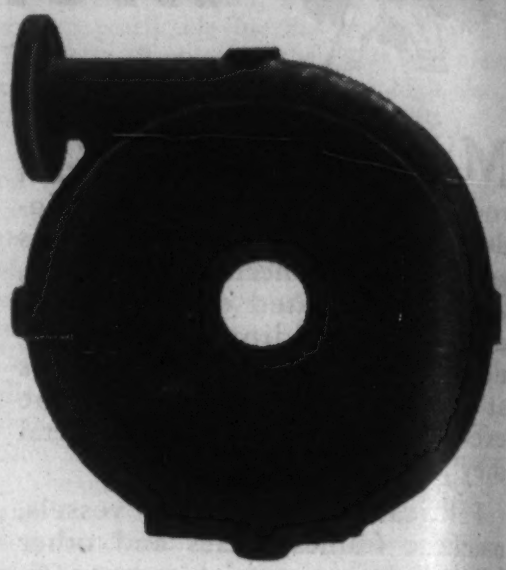
Condensed from "Automobile Engineer"

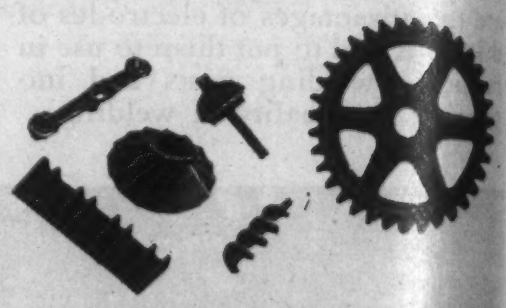
In order to improve the manufacture of heavy duty pistons, Specialloid, Ltd. replaced the hammering process for breaking down cast structure in billets by using extruded aluminum stock. Advantages of extrusion are that the slower and controlled rate of speed of the hydraulic press ensures gradual and uniform distribution of the plastic deformation over a greater volume than is possible with deformation imparted by drop hammer.

Furthermore, the mechanical and physical properties of the piston structure are improved, in particular as to the grain flow, which can be controlled transversely over the head of the piston and to sweep round to a vertical form over the piston walls. Stamping does tend to create partial directional flow, but advantages derived from this partial directional flow are lost during machining.

In ingot casting usually water-cooled molds are used, but improved technique has been adopted, whereby the thickness of mold is reduced so that water cooling can

STAINLESS STEEL CASTINGS
Resistant to Acid Corrosion and Heat



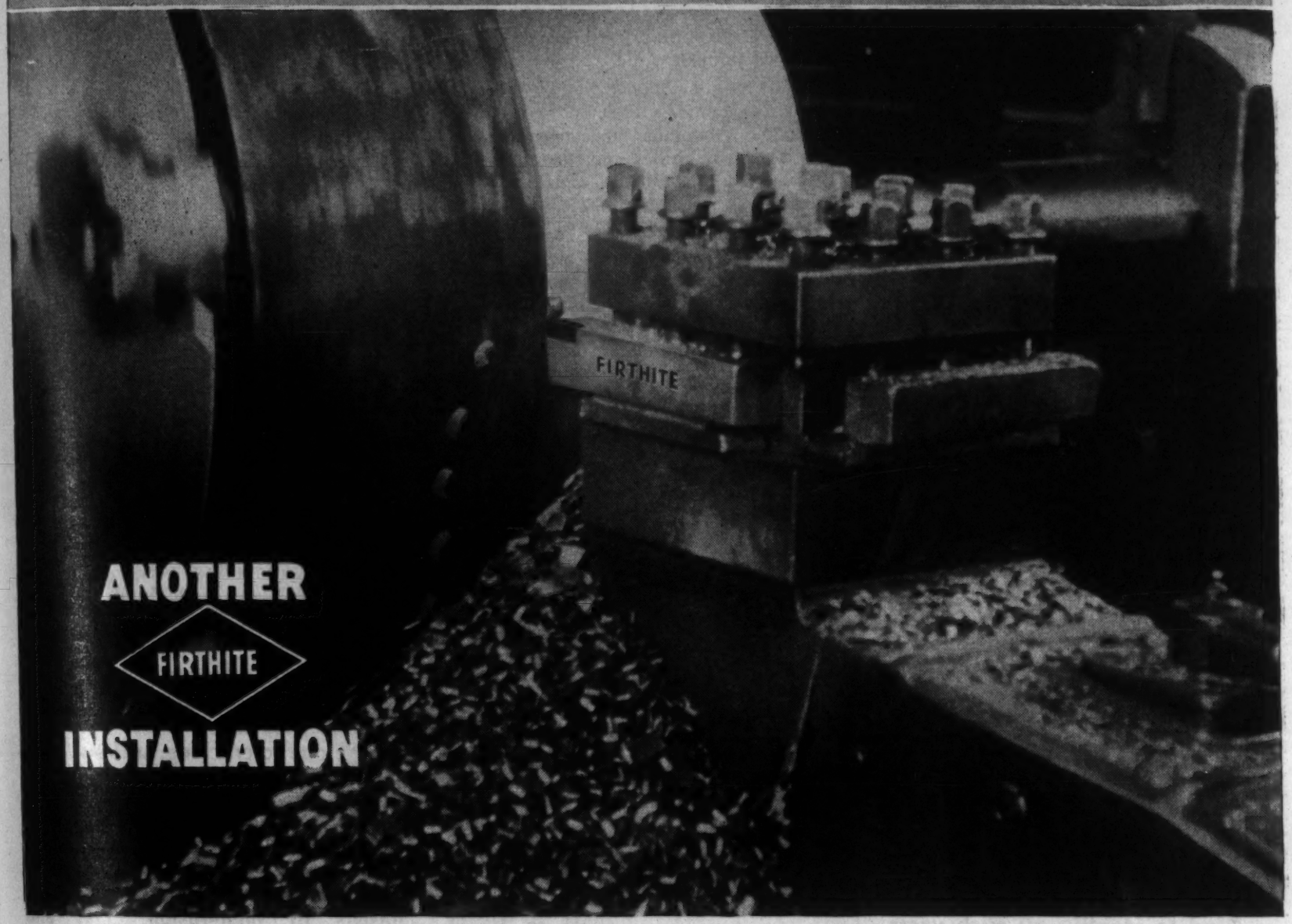


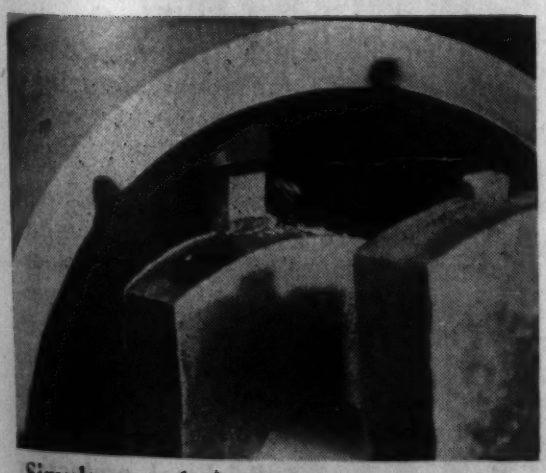
In the manufacture of Stainless Steel Castings it is important to know how! Atlas metallurgists have been specializing in the casting of corrosion resistant alloys for over 20 years, and have pioneered many of the revolutionary methods used today for casting corrosion resisting alloys. Every Atlas Stainless Steel casting is designed purposely for the particular job. Atlas foundrymen do know how! Your inquiries are invited.

Write for illustrated bulletin.

ATLAS
STAINLESS STEEL CASTINGS
Division Atlas Foundry Co.
520 LYONS AVE. IRVINGTON, N. J.

730 POUNDS OF CHIPS PER HOUR!





Simultaneously in **boring** these castings, FIRTHITE Tools take five shocks per second on a severe, interrupted cut.

On **rough turning** this 20″-dia. gray iron casting, with only chuck support, a FIRTHITE Sintered-Carbide Cutting Tool takes a ½″ cut, 0.042″ feed at 170′ per minute—far beyond the capacity of high-speed steel tools.

FIRTHITE cuts clean and free with little pressure at high speeds . . . produces remarkably smooth and even finish. For **super** production, on **any** metal or non-metal, investigate FIRTHITE. Write today for descriptive literature.

ARMY E NAVY

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STRENES METAL

IN FRONT LINE OF SERVICE

BEFORE THE WAR

Strenes can be cast to shape. Most of the usual machining time is saved. Redressing is reduced. That is why before the war Strenes scored heavily as forming and drawing die metal. In one case around 2,000,000 stampings were obtained and the die is still in good condition, ready to resume operation at the end of the war. Runs of 100,000 pieces up are not uncommon. Hundreds of the largest plants in the country used it regularly in their tooling programs. Want the names of pre-war users of Strenes?

IN THE WAR

Strenes today is being used for draw pots, draw pot inserts, draw rings for draw bench operation, for progressing upsetting dies—all in shell manufacture. Glad to identify all such users and many others.

AFTER THE WAR

After the war, refrigerator, stove, metal casket, grave vault, farm implement and other manufacturers will resume with Strenes metal forming and drawing dies. Many of the automobile, truck and tractor builders are extensive users, for body, fender and hood dies. Will name them to interested inquirers.

Look into the merits of Strenes metal—Try it, at least once.

THE
ADVANCE FOUNDRY CO.
DAYTON, OHIO
100 Parnell St.

be applied to the container directly after pouring, giving a rapid chilling.

The container into which the billet is placed is electrically heated and maintained at proper temperature. Extrusion pressures are in the vicinity of 3000 tons.

A complete assembly of die plate, die holder and bolster fits into the mouth of the ingot container to prevent metal from escaping. Pressure is applied through the ram to the pressure disc to the ingot, which is forced through a die.

Close control of ingot temperature within narrow limits is essential to successful working. Aluminum and magnesium alloys are easily chilled and, therefore, it is necessary to preheat the container before the ingot is inserted.

In the manufacture of extruded bar stock, a certain degree of piping occurs, but if correct conditions are maintained the pipe does not develop until towards the end of the extrusion. To eliminate piping, a length called the discard is cut from the end after extrusion is complete.

For the manufacture of pressed pistons the presses may be hydraulic, friction screw type or of the eccentric crank pattern. Specialloid, Ltd. uses Leowy hydraulic presses, and they are rated at 1,000 tons capacity.

To obtain the desired physical properties, pistons are heat treated after press forming. A typical heat treatment is to soak at 510° C. (950° F.) for 6 hrs., with temperature held within ± 5° C. (10° F.) in order to take the hardening constituents of the alloy into solution, then to quench in boiling water. The charge is allowed to remain in the boiling water for 4 hrs. to precipitate the hardening constituents. Vertical-type air circulation furnaces are used.

A considerable amount of physical testing is carried out to ensure that products conform to a very high standard.

—*Automobile Engr.* Vol. 33, Sept. 1943, pp. 349-359.

Black Finishes on Aluminum

Condensed from "Metal Finishing"

Chromic acid anodizing is commonly done to provide a corrosion resistant coating on aluminum. For producing anodic films which were to be dyed for decorative purposes, sulfuric or oxalic acid anodizing baths have in the past been considered more practical.

However, attractive and durable black and colored chromic acid anodic films can be readily produced on aluminum and its alloys. These dyed films are finding numerous uses in the fabrication of aircraft parts and other war implements, and will undoubtedly find still wider application after the war.

Parts to be blacked should be properly racked and not touched by hand, otherwise fingerprints may appear on the finished surface. Cleaning may be carried out in a

BRICKSEAL

Assures COMPLETE PROTECTION and LONG LIFE for Refractories

★ Highly-glazed monolithic coating prevents cracking and spalling

Brickseal will reduce to a minimum the danger of untimely failure of furnace refractories. This widely-used refractory coating, applied like paint with brush or spray gun, forms a highly-glazed, heat-reflecting, monolithic, protective surface which prevents damage due to cracking, spalling, slagging, air infiltration and sudden temperature variations.

Brickseal should not be confused with ordinary air-set washes which form a plaster-like surface coating. Brickseal consists of high-fusion clays and metals combined in oils. Furnace heat burns the oils and vitrifies the clays and metals, which penetrate deeply into all pores, cracks and joints, binding the bricks into a durable, monolithic wall.

Brickseal cannot crack, blister or peel off due to sudden temperature changes because, at operating temperatures, it becomes semi-plastic, permitting it to expand and contract with the wall. Brickseal also binds old cracked or loosened bricks. Slag may be removed without damage to lining.

You can secure Brickseal protection with very little cost or delay. Write for sample today.

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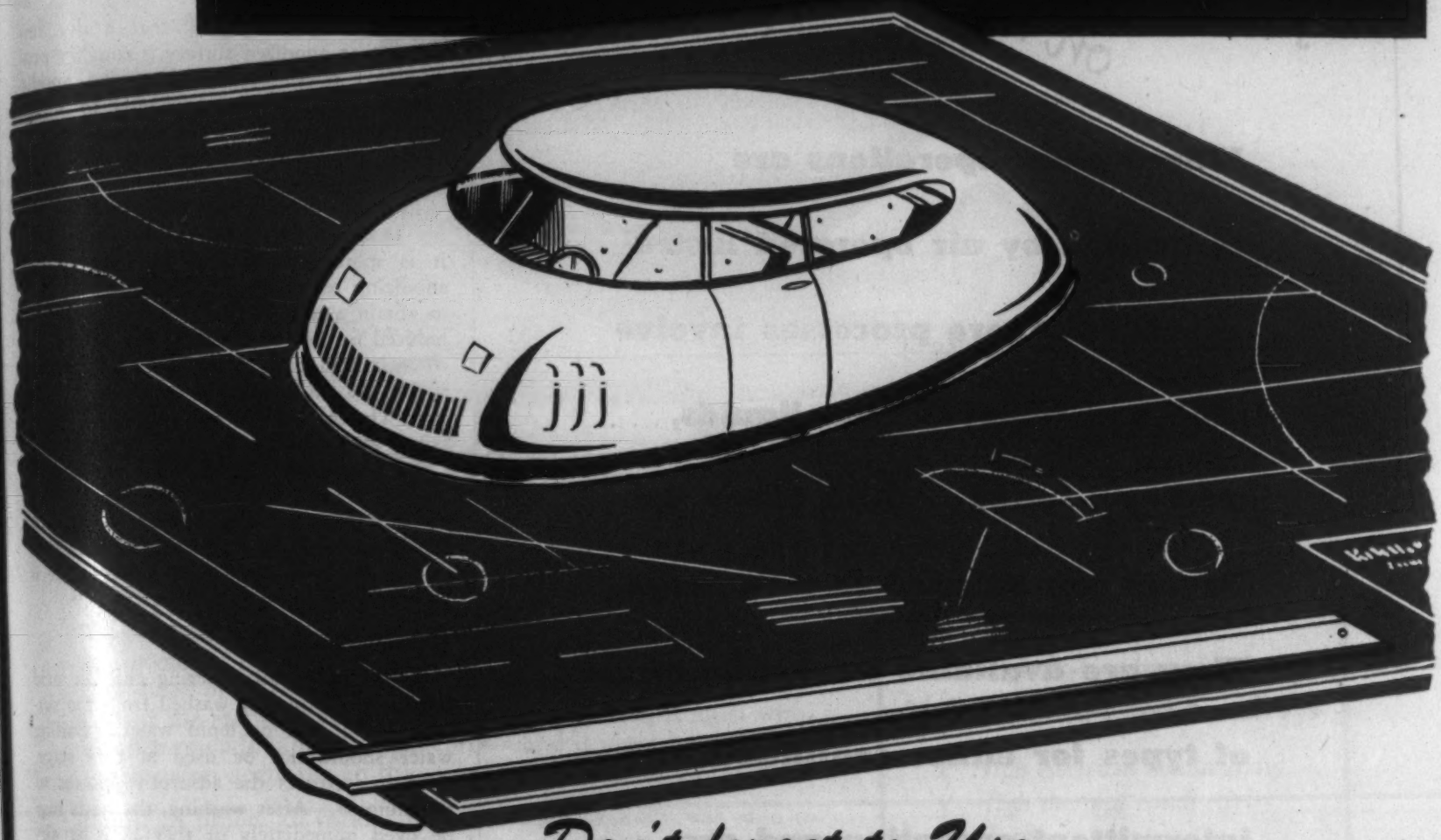

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For over twenty years MACDERMID INCORPORATED has specialized in the formulation of special compounds for cleaning basis metals and today this individualized service to manufacturers is of more importance than ever. New products will necessitate entirely different types of metal cleaners. New low cost production schedules will demand lower cleaning costs. New finishes will need special pre-finishing treatment. New alloys will have to be cleaned in a more exacting way than yesterday's alloys and metals . . . Don't wait until the whistle blows! A qualified MAC DERMID INCORPORATED representative will be pleased to help you now with your post war planning; show you the new, faster acting compounds that have been recently developed for modern materials and cleaning methods. No obligation, of course, our organization has been built on service to industry.

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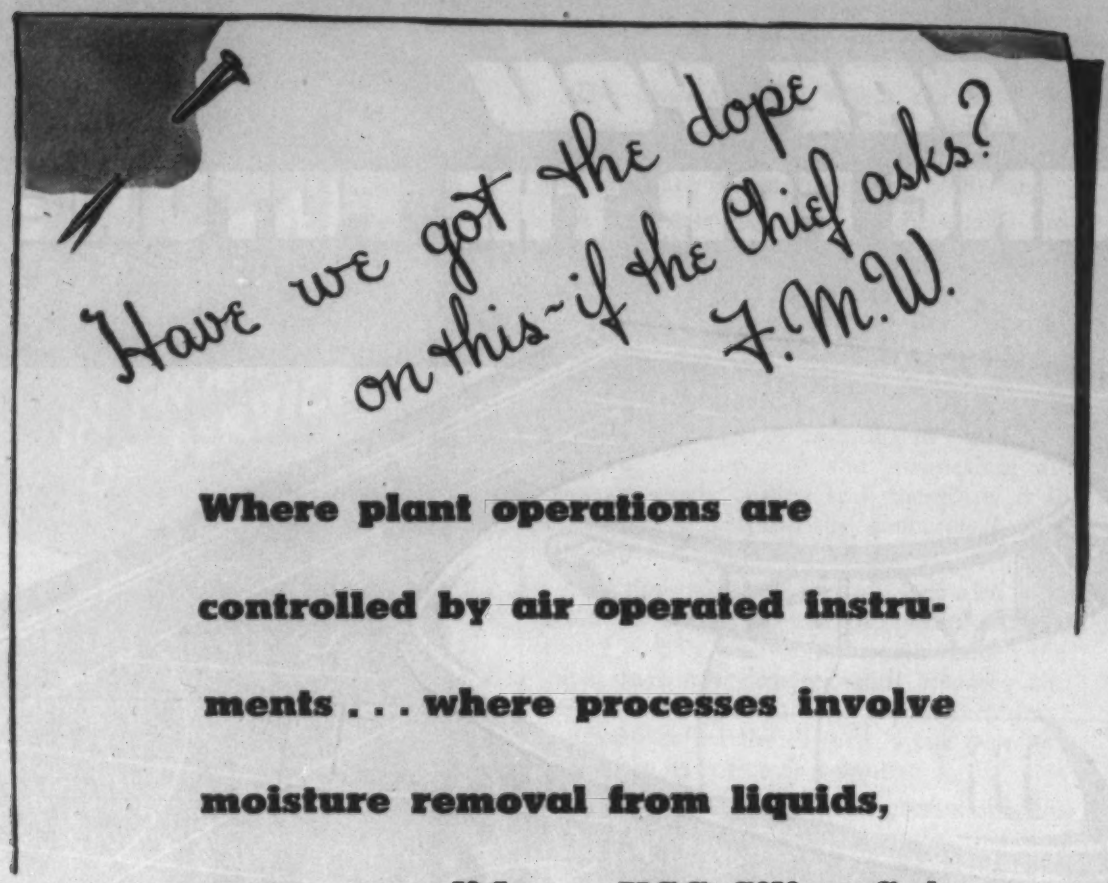

Where plant operations are controlled by air operated instruments . . . where processes involve moisture removal from liquids, gases or solids . . . KSG Silica Gel Dryers can be used to advantage. They are available in a wide range of types for either continuous or intermittent operation and are meeting requirements of 20 cfm to 100,000 cfm at dew points as low as –60° F.

For descriptive bulletins, specific information or engineering assistance, address The C. M. Kemp Mfg. Co., 405 East Oliver Street, Baltimore-2, Md.

ARMY E NAVY

KEMP of BALTIMORE

solvent or in a suitable alkaline cleaner. Following cleaning, the parts are anodized directly if a reflective finish is desired.

If a dull finish is desired, the parts are either mechanically roughened, or etched by immersing in dilute alkali or nitric acid. Hydrofluoric acid may also be used for etching, particularly for silicon-containing alloys. The parts are then rinsed, dipped in concentrated nitric acid, rinsed, and then anodized.

The intensity of black that a dye imparts to an anodized surface is roughly proportional to the thickness of the anodic film. Films that are sufficiently thick for corrosion protection or for a good bond to a paint primer may not be thick enough to give a good black.

In order to obtain heavy films, the anodizing time may be increased, but in general it is more advantageous to increase the anodizing temperature. The time required to obtain a film suitable for dying may be reduced further by lowering the pH of the chromic acid bath. The ordinary concentration of an anodic bath is 50 to 100 g./l. chromic acid, with the pH maintained at 0.8 to 0.9.

On anodizing for 60 min. at 40 volts in such a bath, films are obtained that are suitable for most dying purposes. Anodizing longer than 90 to 120 min. at 125° F. seldom improves the film, and may make it powdery and uneven.

Dying Procedure

Before dying, all adhering chromic acid should be thoroughly washed from the surface, using cold or tepid water. Boiling water should not be used at this stage, since it decreases the adsorptive power of the alumina. After washing, the parts may be dyed immediately or they may be air-dried. Several days standing, or oven drying a short time at 160° F., does not injure the adsorptive power of the film.

The dye bath is prepared by dissolving the dye in tap water and adjusting the pH, if necessary, with nitric acid. Usually Nigrosine JB is used at a concentration of 5 g./l., a pH of 7 to 8, a temperature of 180° F., and an immersion time of 30 min. After dying, the work is rinsed in hot water and dried.

Considerable experimental data are given on the effect of variation of anodizing time, temperature, voltage, pH, bath composition, variations in the dye bath, etc.

High silicon die-castings, forgings and stampings were successfully dyed.

Properties of the dyed film on alloy 17ST are shown in the following table:

Appearance: jet black with a high even gloss.
Mechanical fastness: satisfactory.
Light fastness: unaffected by 130-hr. ultraviolet test.
Water resistance: no bleeding after 60-min. boil.
Corrosion resistance: passed 250-hr. salt spray test.

Considerable laboratory work has also been done on the development of procedures for the production of colored films —reds, yellows, greens and blues—and excellent results have been obtained, which will be reported later.

—Marc Darrin & L. G. Tubbs. *Metal Finishing*, Vol. 41, 1943, pp. 550-552, 580

It Spins 3 Times as Fast as an Airplane Motor!

Tough to Make...
But Mallory 3 Metal Does the Job!

This is a casting of a small disc used as a counter-balance and motor mount for a gyroscopic unit. The disc is required to turn at a speed of 12,000 revolutions per minute—but that's only a part of the story. It must be non-magnetic metal, it must withstand tremendous centrifugal force—and it must be machined to precision accuracy so that vibration is held to a minimum.

Quite an order, all in all, but one which Mallory was able to fill with complete satisfaction and promptness. It was as simple as prescribing a non-ferrous alloy, already in use and widely tested. This alloy, Mallory 3 Metal, is comparable to copper in its density, coefficient of resistivity, coefficient of expansion and modulus of elasticity, while its strength and resistance to fatigue far exceeds that of copper.

Mallory 3 Metal, however, is only one of a family of numerous non-ferrous alloys meeting unusual requirements. Others are Mallory 53B, 53Z, 73, 100 and 1000 metals, Elkaloy* and Elkonite.* Complete detailed information about them will promptly be sent by mail. And if you have special difficult problems, Mallory engineers will be glad to help.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

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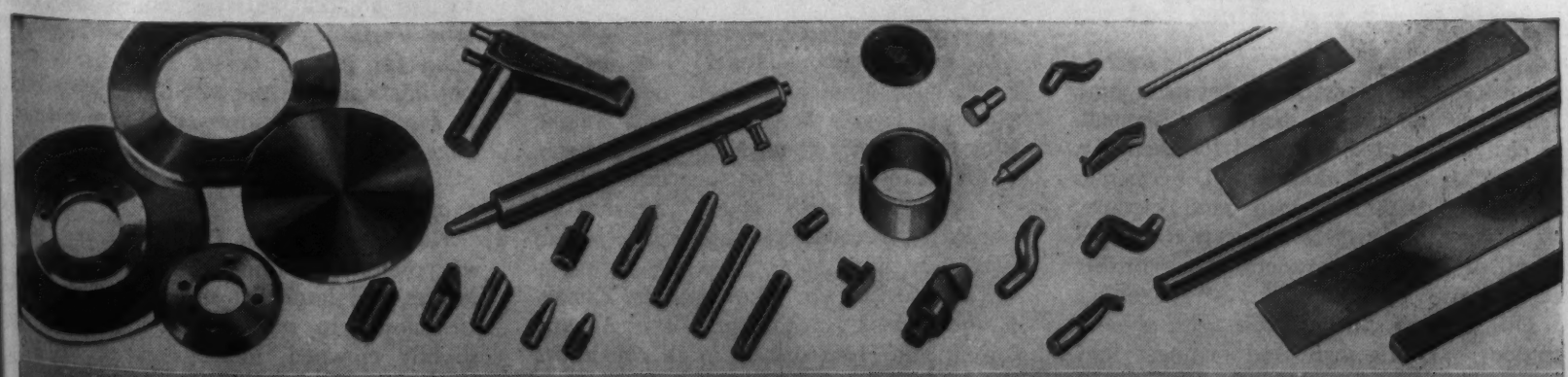

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NON-FERROUS ALLOYS—MALLORY 3 , 53B, 53Z AND 100 METALS — ELKALOY* AND ELKONITE*

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4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Designing Die Castings

Condensed from "Product Engineering"

In considering whether the die casting process shall be used from a cost standpoint, remember that dies for die casting frequently cost less than dies needed for stamping, forging or plastic molding. Die castings need less machining than sand castings. With die castings there is always the likelihood of additional orders, thus further cutting costs.

Die castings can be made with thinner sections or walls than sand castings; they usually require no grinding or buffing prior to plating. Yet die castings rarely compete with a wrought part of steel, are softer than many ferrous alloys, have some porous sections, and are sometimes subject to creep.

Zinc alloys account for 75% of the tonnage, with aluminum alloys next in importance, largely because of light weight. Zinc casts easily at moderate temperatures, is lowest in cost and has superior mechanical properties except copper. Finishes are smooth, and moderate temperature means longer die life.

The principal zinc alloys used are Zamak-3 and Zamak-5, containing 4% Al and 0.03% Mg. Iron content in all zinc alloys should be kept under 0.10%. Zinc alloys are not suitable where in contact with steam and, perhaps, water.

Aluminum alloys die cast at 1100-1300° F., or about 400° higher than zinc, hence finished parts can stand more heat than zinc. Magnesium alloys are used where extremely light weight is needed, are about equal to aluminum, yet have a fire hazard. Copper-base alloys are cast at the highest temperature of all alloys, this being hard on dies.

Porosity in die castings is often caused by trapped air, though this is often remedied by gating and venting.

There are many do's and don'ts in designing for die castings. Keep size at a minimum consistent with other requirements. There are, of course, cases in which a single large piece costs less than two single ones cast separately.

All sections should be of minimum thickness consistent with reasonable ease of casting and with adequate strength and stiffness, since thin sections cool faster, hence, are stronger and have a smoother surface. Make sections as nearly uniform in thickness as possible; at least make a gradual transition from thinner to thicker sections. Unequal thickness, resulting in contractions, cause a shrinkage stress, warpage and cracks.

Cores Save Metal and Work

Provide for cores wherever consistent with other requirements, as they save metal, machine work, make for sounder castings, and lower cost. Avoid cores of extreme length, especially slender cores. Often it is feasible to core part of the hole and to drill the remainder later.

Cores should be placed where they can be withdrawn with a minimum of parts for withdrawal and locking of area. Fixed cores, attached permanently to the die, need no operating mechanism and are cheapest. See that cores have the simplest shape possible. Design the casting so that the machine cost is cut without undue sacrifice in accuracy, appearance and performance of required functions.

Design the castings so as to minimize the cost of flash removal. Flash always occurs at die partings and joints, whereas slides and movable cores form crevices in the wall of the die cavity. Flash at the parting is removed by a shaving die through which the casting is forced by a press.

Avoid the use of undercut castings that require the use of slides in the die, except where offsetting advantages are outweighed. Bosses and projections on the sides of castings are often extended to the parting line to avoid undercuts.

Fillets should be used at inside corners where surfaces join and at exterior corners to join adjacent surfaces, unless there is a special reason for squareness. They are good for joining bosses and ribs to supporting walls of the casting, as they help to avoid localized stresses. Sharp exterior edges and corners add to buffing and plating difficulties as well as to die machining costs.

Keep the shape of the casting as simple as possible, avoiding unnecessary irregularities and large flat surfaces. The latter are subject to warpage. They should be slightly crowned, thereby adding strength and stiffness and providing highlights to mask surface defects.

Never specify tolerances closer than are essential. Dimensions, however, can be held within closer limits than in sand casting. Provide sufficient metal at all points

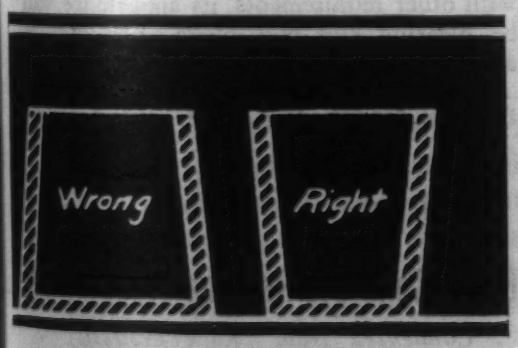
DESIGN DATA ON PLASTICS

I. Efficient Production

FROM THE DUREZ LABORATORIES

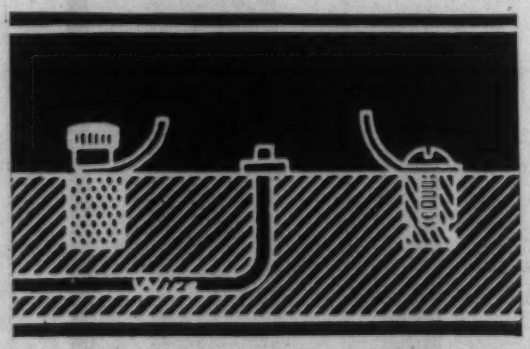
The engineer who is designing plastic parts usually finds himself facing five major considerations: (1) ease of production, (2) purpose of the part, (3) service conditions, (4) cost, (5) selection of materials.

Within these broad categories there is a wealth of opportunity for good design technique, and almost as many pitfalls. Our own experience never fails to emphasize one all-important fact. *A satisfactory plastic part is most often obtained when there is close cooperation between product engineer, molder and the producer of the plastic material.*



UNDERCUTS: They run up costs . . .

Durez compounds provide you with unusual latitude when it comes to moldability or ease of production. But a study of twenty years of data files on literally thousands of designing problems indicates there may be many factors involved. Of these factors, the following are especially important:



INSERTS: Imbedding in Durez makes important savings . . .

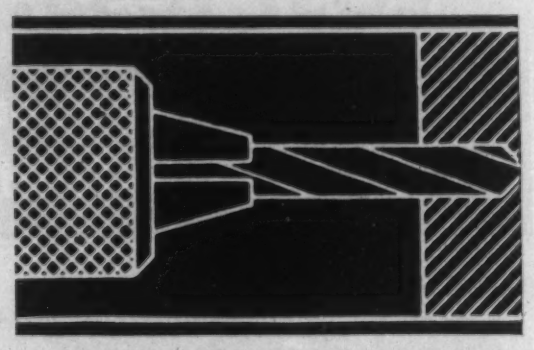
Undercuts should be avoided wherever possible because Durez sets up hard in the mold. Split molds can handle undercuts, of course, but it runs up cost.

On the other hand, when it comes to inserts, Durez will help you to keep cost down because contacts, terminals, wires and inlays can be imbedded during the molding process. This makes later assemblies easier, less expensive and stronger.

Provided they can be withdrawn from mold, decorative details can be included in any Durez piece. Simple lettering and trademarks involve no problem.

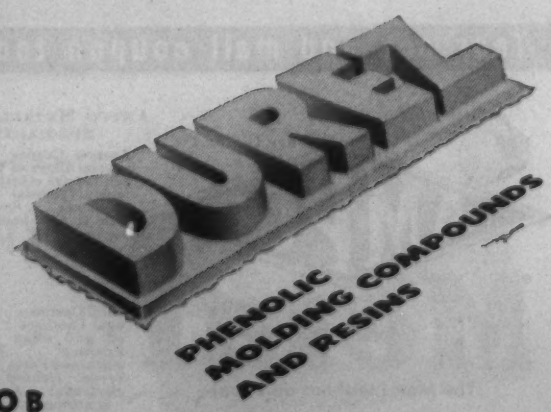
Strong, precise threads are easily molded, permitting permanent joining of sections, or easy removal without binding.

With Durez materials, it is practical to include machining. However, good designing can eliminate much machining which is always costly and should be avoided. Of course, a machining operation will sometimes eliminate a split or complicated, costly mold.

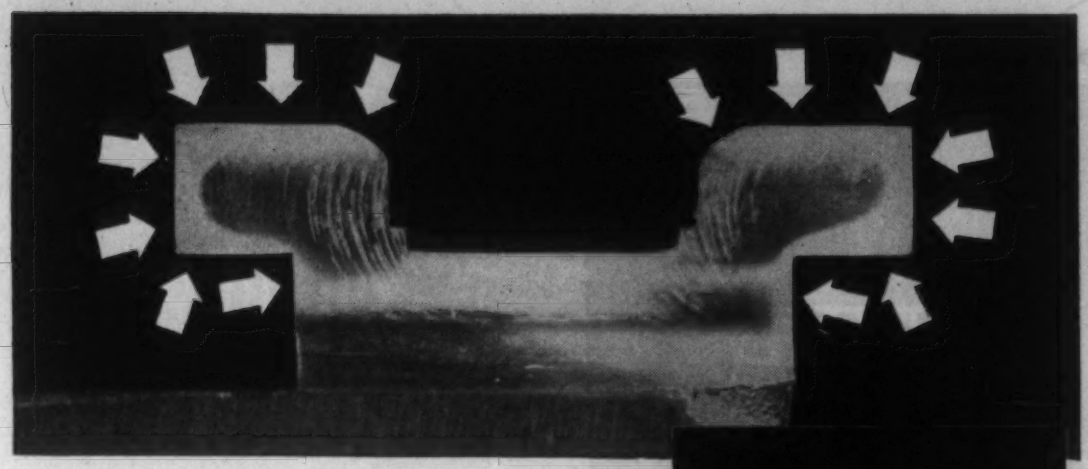


MACHINING: Good designing can often avoid costly machining . . .

Here we are only scratching the surface on the moldability of Durez compounds. Our files probably include much interesting data on cases which are similar to your own problem. If you have a plastic part or product in mind, we should like to hear from you. We offer our laboratory facilities and the experience of qualified technicians in helping you find your answer. Durez Plastics & Chemicals, Inc., 91 Walck Road, N. Tonawanda, New York.

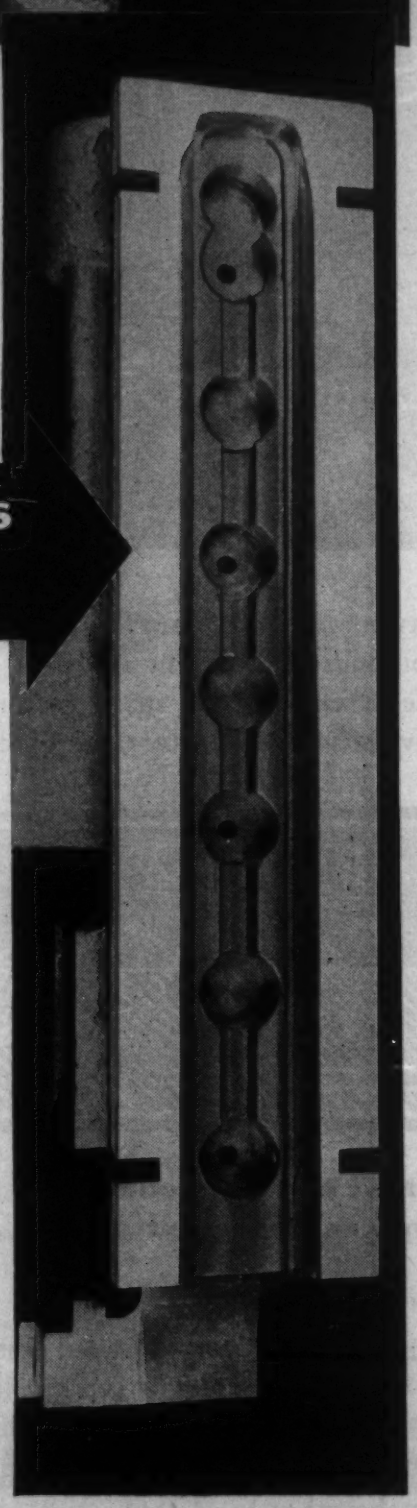


PLASTICS THAT FIT THE JOB



Bearing surfaces of wear-resisting Ampco Metal cost less..

-with welded overlays of Ampco-Trode



Welding—the fabricating method which has made such tremendous strides in war production—offers you an economical means of building up surfaces that resist wear, shock, and corrosion.

With Ampco-Trode, you can overlay less costly base metals with the same high-quality aluminum bronze which has found such wide acceptance in the form of castings and wrought products as Ampco Metal. Any grade of Ampco-Trode—selected for your required physical properties—can be welded to almost all metals and their alloys.

From giant marine propellers to the smaller machine parts or valve seats, you can apply aluminum bronze where needed. (Illustrated: gun slide overlaid with Ampco-Trode on bearing surfaces.)

Your questions on specific applications will be gladly answered by the nearest Ampco field engineer. Don't delay—call or write today.

Write for Ampco-Trode catalog.

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where machining is required, although usually a cut of 1/32 to 1/64 in. below the cast surface is all that is necessary.

Ample Draft Necessary

Allow ample drafts both on cavity walls and on cores. Though they are less than for sand castings, they should not be so small as to interfere with ready ejection of the casting or easy pulling of the cores. See that ejector pins are so located as not to leave objectionable marks on the finished casting.

Employ integrally-cast fastening parts wherever their use will lower assembly cost and meet other requirements. Provide for cast threads where they reduce cost over cut threads. Cast internal threads are used only in zinc alloys, when threads are fairly coarse and when diameters are over ¾ in.

When a gear, gear segment, cam, ratchet or such part is needed, consider die casting either as a separate piece or integrally with some other part. Precision is far better than for sand cast gears. Arrange, where feasible, for a combination of multiple parts, designing the casting so that it will combine as many parts needed in the completed unit as conditions permit and still avoid undue complexity and costs.

Make use of combination dies wherever cost can be lowered. Sometimes combination dies are feasible when the parts are not for the same assembly. A common frame or chase usually holds two to six small dies and are filled simultaneously. They can be changed individually. They are best for small, simple castings with simple coring.

Employ inserts, usually of different materials, where certain parts of the casting must be stronger, where the insert is an element not feasible to cast, or is a part that cannot be held together well by means other than die casting. Wood and even paper inserts have been used in addition to steel, with charring of the wood or paper negligible.

Design the casting so that, consistent with other requirements, its appearance will be pleasing and will blend with that of mating parts.

—H. Chase. *Product Engineering*, Vol. 14, Apr. 1943, pp. 237-242; May, pp. 303-307; June, pp. 376-379.

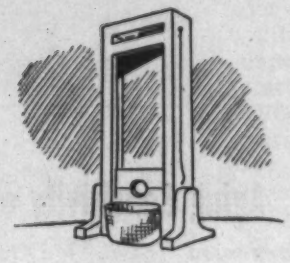
Brick, Concrete Replace Steel in Kiln

Condensed from "Rock Products"

Due to the scarcity of steel at the present time, two new shaft kilns were designed, one consisting of brick walls reinforced with steel bands, the other brick-faced reinforced concrete. The usual internal fire brick lining, common to these kilns, is used.

Of the two designs, the former is the simplest and probably the best, but requires specially perforated red brick. Only about two tons of rods and bands are needed. The rods pass through the brick, lining them up while the bands tie everything together. The face bricks are the best grade of common red hard-burned bricks.

GUILLOTINE FOR *Gremlins*



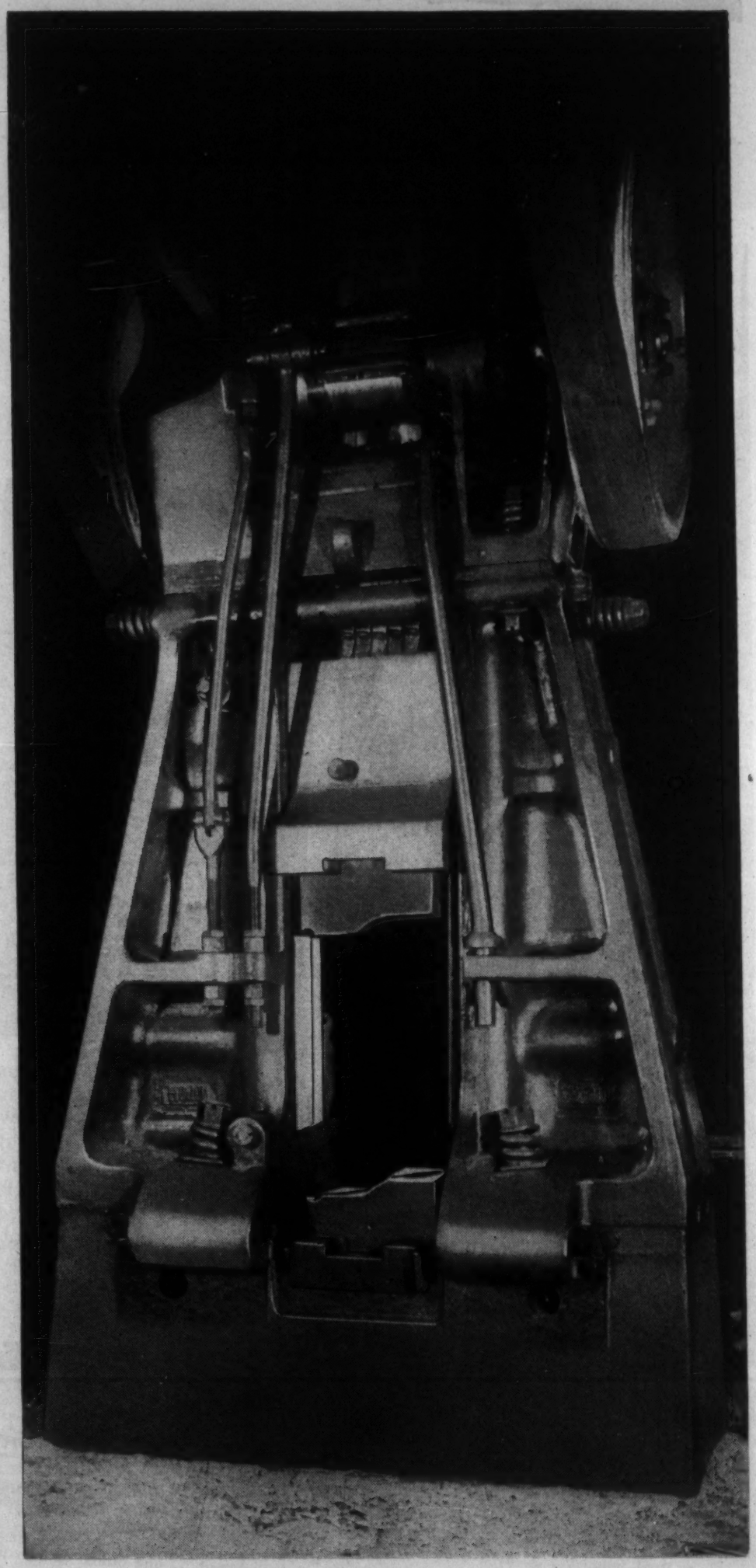
C-R-A-S-H!!

The hammer drops. And with each blow it kneads the heated metal into a tough, sinewy mass from which all unseen flaws . . . hidden defects . . . the trouble-makers so often found in metal . . . are eliminated. And the metal takes the exact form of the precision-made die into which it is forced.

That's drop-forging . . . the method by which the grain structure of iron or steel is changed . . . improved . . . while the part is being forged. It's the method by which Phoenix is producing many important implements of war that must withstand the most punishing shocks and strains.

Forgings by Phoenix have long since demonstrated their superiority in machine parts and tools that must have exceptional strength and endurance. They reduce costs, too, for they can be held to tolerances that make very little machining necessary.

In planning improvements in your product, you may find it to your advantage to consult Phoenix. There's no obligation.



PHOENIX MANUFACTURING COMPANY

CATASAUQUA PENNSYLVANIA

Forgings by **PHOENIX**

STAINLESS STEEL PARTS NOW CAST CENTRIFUGALLY

New Method Replaces Forging and Fabricating in Many Cases

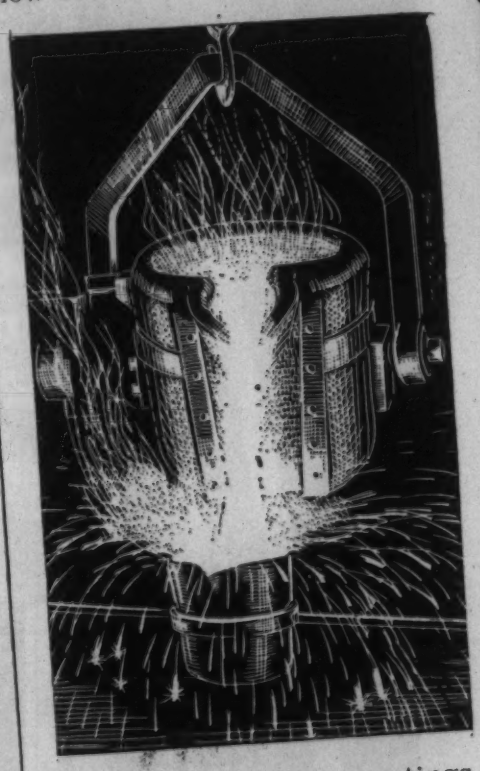
HILLSIDE, N. J.—A new method of casting stainless steel centrifugally has recently been developed by The Cooper Alloy Foundry Co. of this city. According to company spokesmen, parts formerly forged or fabricated can now be cast successfully—with resultant savings in cost, man-hours and delivery time.

Cooper has already demonstrated the ability of his new process to crack critical bottlenecks in the manufacture of mass-produced equipment for airplanes. Many such parts are now produced in record time.

Centrifugal casting of stainless steel, however, provides industry with much more than a new way to speed vital war production. It means that either the static or the new centrifugal method can be used —whichever is better, or more economical, or faster.

The Cooper Alloy Foundry Co., where the new process was developed, has specialized in the production of stainless steel, monel, nickel, chrome iron, chrome nickel and other alloy castings since 1922. It offers users of corrosion, heat and abrasion castings a complete alloy casting service—including practical assistance in the selection of alloys.

Concerns interested in the possibilities of this new process are invited by the company to submit descriptions



(with sketches) of the castings, fabricated parts or forgings they now use, together with notes on any special requirements. Company engineers will then make recommendations. Users will not be obligated in any way in taking advantage of this service.

THE *Only* ALLOY FOUNDRY WITH *All* THESE FACILITIES

- Laboratory control over raw materials and finished products.
- Dual foundry . . . both hand and machine molding.
- Centrifugally-cast castings.
- Heat treating of castings up to six feet in size.
- Machine shop . . . specially equipped for finishing stainless steel.
- Improved cleaning . . . including Lustracast electrolytic finishing which leaves all surfaces bright.
- Castings furnished rough, polished or fully machined . . . one ounce to two tons.
- X-ray and Gamma-ray inspection.
- Development of special alloys to meet unusual requirements.
- Technical consulting service.

THE *Cooper* ALLOY FOUNDRY CO.

105 BLOY STREET • HILLSIDE, NEW JERSEY

Behind the outer wall proper there is a 3-in. row of insulating brick placed there, as much to take up some of the expansion strain from the outer wall as to insulate it against heat loss.

In building, both the outer and inner fire brick wall would be carried up together. At the poking openings the door frames would be bolted to the bands.

The other design was evolved from standard methods of chimney construction. It is reinforced concrete between two walls of red brick.

Prices at present would compare as follows: Kiln shell, 10 by 12 by 40 ft., steel shell kiln only, $1,600; reinforced special red brick, $575; and reinforced concrete, $525.

—Victor J. Azbe. *Rock Products*, Vol. 46, Sept. 1943, pp. 78-79.

Aging Sensitivity of Steels

Condensed from "V.D.I. Zeitschrift"

Former investigations had established the fact that certain defects and failures in structural steels are due to aging which, on the basis of laboratory experiments, could be eliminated by melting such steels (particularly the weldable ST 52) with aluminum as deoxidizer. It was now found that normally melted and produced (*i.e.* in normal operation) steels ST44 and ST52 behaved in the same way as steels produced in the laboratory, *i.e.* they showed a distinct tendency to embrittlement by aging, which also could be reduced by an increased deoxidation with aluminum while normalizing alone did not prevent it.

The normal melts were investigated with respect to embrittlement tendency from three angles: (1) The condition as delivered as measured for the toughness of the steel before and after installation. (2) The normalized condition (heating above the critical temperature, cooling in quiet air) as state of the greatest practically obtainable toughness for the respective material. (3) The aged condition as measure for the greatest occurring embrittlement, a condition that eventually can be obtained after installation even though only at places of local overstressing. The toughness was determined by the notch-impact test.

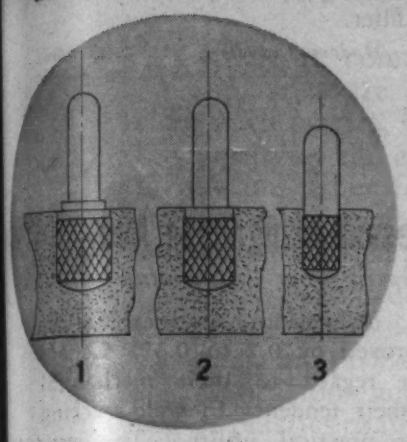
The above mentioned conclusion of these tests were confirmed by the examination of the material of two bridges that failed; both materials were satisfactory in the delivered state and showed strong aging sensitivity in the parts taken from the bridge. It is pointed out, therefore, that it is wrong to assume that a structural steel is stressed only in the elastic range; in settling, the structure almost always undergoes plastic deformations, mostly of local nature, which exceed the elastic limit, and thus prepare the aging process leading to failure if the material is not properly selected and produced.

—A. Fry & L. Kirschfeld. *Z. Ver deut. Ing.*, Vol. 87, Mar. 6, 1943, pp. 123-127.

(Continued on page 200)

Designing Molded Plastics Parts: INSERTS

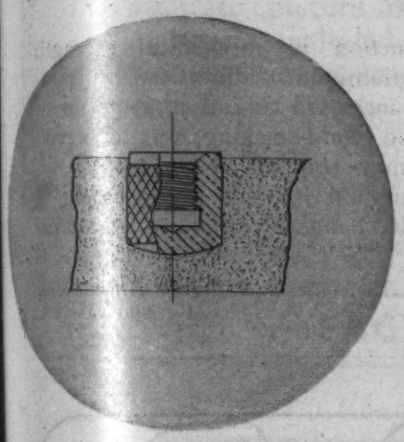
From the engineering files of One Plastics Avenue



ROD AND WIRE INSERTS

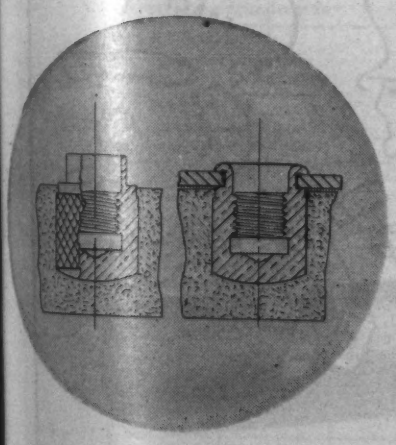
Three types of inserts may be used. Good practice calls for inserts whose imbedded length is twice their diameter, although size of insert, type of mold, compound and support will permit greater slenderness ratio.

(1) Design with double shoulder provides best compound seal, added strength in molding when exposed diameter is extremely small. (2) Single shoulder provides reasonably adequate compound seal. (3) Lacking shoulder for compound seal, this design necessitates added finishing operation, increases part cost.



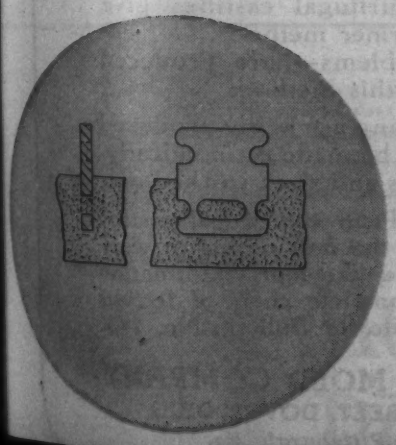
THREADED INSERTS

Threaded female inserts should be proportioned to provide suitable anchorage in compound, strength to resist crushing in molding and sufficient length of thread. Illustration shows well-designed female insert with shoulder which provides compound seal, countersink at start of thread, undercut at bottom for tap relief and coarse knurl.



SPUN-OVER INSERTS

This type is used to provide a permanent assembly of contact strips, washers, etc. to the molded part. Except for tubular projection this type of insert should incorporate the same principles of design as threaded inserts. Illustration shows insert as molded and after assembly.

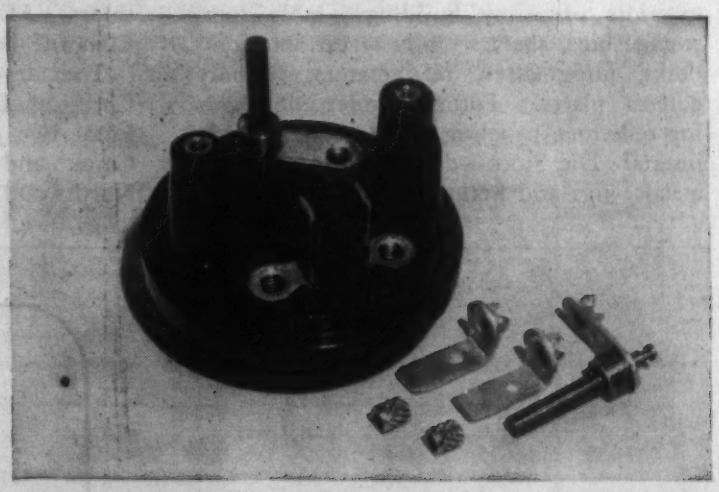


STAMPED OR PUNCHED INSERTS

Close tolerances are required at dimensions where inserts fit molds. Through-holes in imbedded portions provide additional anchorage.

To incorporate inserts in molded plastics parts the following general factors should be considered:

1. Use of delicate inserts should be avoided for compression type molds.
2. Simple shaped inserts, preferably round, are more easily cleaned after molding.
3. Minimum thickness of plastics material recommended around insert:
   - 3/32 in. for 1/4 in. insert
   - 1/8 in. for 1/2 in. insert
   - 1/4 in. for inserts over 1/2 in.
4. Inserts should be placed at right angles to parting lines.
5. For good anchorage, knurl, punch or groove inserts.
6. Where heavy service loads are encountered insert should carry the stress.
7. Where inserts are used as electrical contacts, provide sufficient clearance at points of arcing to avoid burning the surface of the plastic material.



TYPICAL APPLICATION Typical of molded parts incorporating inserts is this electrical switch section which has five separate inserts including each of the major types—rod, threaded and stamped.

ADDITIONAL FACTS General Electric has 16 standard female brass inserts. Inserts of G-E mycalex, porcelain, woven wire mesh, laminated phenolic material, woven glass, etc., can be molded in plastics parts. The services of G.E.'s Plastics Divisions product engineers are available for advice on your design problem.

ONE PLASTICS AVENUE at Pittsfield, Massachusetts, is the headquarters for five plants of the Plastics Divisions of General Electric Company. It signifies the location of complete plastics facilities for development, material manufacture, designing, engineering, moldmaking, molding and laminating.

REPRINTS of this advertisement may be obtained by writing Section F-212, General Electric Plastics Divisions, 1 Plastics Avenue, Pittsfield, Mass.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M.—E.W.T. NBC. "The World Today" news every weekday 6:45 P.M.—E.W.T. CBS.

"192,000 employees of the General Electric Company are on their jobs producing more goods and buying over a million dollars of War Bonds every week to hasten victory."

PD-212

PLASTICS DIVISIONS

GENERAL ELECTRIC

Plastics from Wood Waste

Condensed from "Modern Industry"

Uses for lignin, the material that cements together the cellulose fibers in wood, are being expanded broadly to many industries. New ligno-cellulose plastic molding compositions and plastic fillers are finding wide applications as replacements for steel and other critical materials — ligno-cellulose boards formed to shapes formerly made of steel, to replace insulators in electrical equipment, and aluminum in foundry pattern plates.

The ligno-cellulose hardboard known as Presdwood is one of the most familiar forms. Lignin gives these sheets their strength, rigidity, hardness, and brown-black color. Other lignin plastics point out the direction taken by the development of the material. As a plastic in an impregnated paper, lignin is being molded into jar caps and closures; as the plastic component in ligno-cellulose boards, lignin has a wide variety of structural, industrial and electrical uses.

Some of the uses of the board material are: Panels—wallboard for interiors and exteriors of Army buildings; table tops, storage bins, shelves; railway car interiors; desks, filing cases, refrigerators, foundry pattern plates. Forms—fluorescent lighting reflectors, paneling for automobile body inserts. Die Stock—dies for forming light metals; jigs and fixtures of all kinds; electrical panels. Miscellaneous uses include gaskets, cams, gears, sheaves, and shell-loading pallets.

Lignin is available in large quantities from paper mill waste, where recovery by two mills alone totals 55 tons a day. This production can now be tripled. Some 300 lbs. of the 500 lbs. of lignin in each ton of wood are recovered by present processes. It is estimated that some two million tons of lignin are burned or otherwise discarded each year, not counting quantities from sawdust and other wood waste.

In plastics, lignin is usually re-combined with wood's other main constituent, cellulose. By the Masonite process, wood chips are steamed at high pressures, then exploded to form a pulpy mat, which is recombined under heat and pressure into hard, flat boards.

Mead Corp. and Marathon Paper Mills Co. recombine the lignin from their waste liquors with pulp to form a paper impregnated with 40 to 50% lignin or more. This paper is formed to desired shapes by fabricators. Marathon also presses the pulp to Lignolite board.

The development work of Northwood Chemical Co. has been taken over by at least two companies, Burgess Cellulose Corp. and Diamond Alkali Co. The Northwood process is designed primarily for the manufacture of plastic fillers.

Ligno-cellulose molding compositions, unless modified with other ingredients, lack the flow characteristics required of a good molding compound. The material is thermoplastic, and so must be cooled before removal from the mold. Mixed with the thermosetting plastics, the composition attains molding characteristics about the same as general-purpose phenolics using wood-flour filler.

—*Modern Industry*, Vol. 6, October 15, 1943, pp. 42-45.

Magnesium-Manganese Alloy

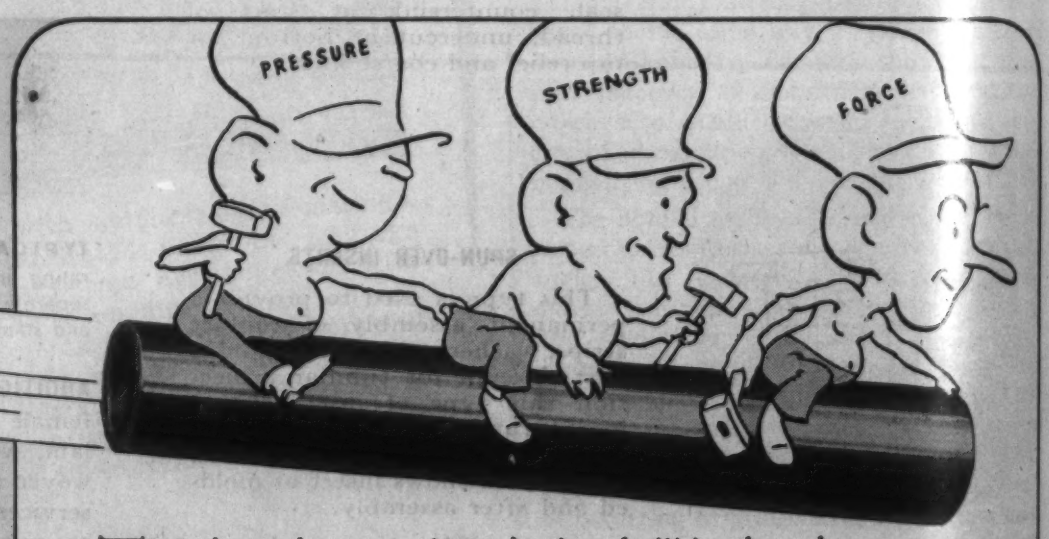
Condensed from "Aluminium"

Although magnesium-manganese alloys can be improved by 0.2 to 0.3% Ce addition with regard to their mechanical properties, their tendency to weld-cracking lowers their practical utility. This can, however, be eliminated by addition of aluminum.

The reduction in mechanical strength due to the aluminum addition can be counteracted by increased cerium content, up to 1.85%. No weld-cracking was observed with aluminum contents above 1.04%.

An explanation for this improvement is found in the change of structure by aluminum.

—H. Mäder & F. Laves. *Aluminium*, Vol. 25, 1943, pp. 157-159.



There is no Substitute for **SHENANGO-PENN** *Centrifugal Castings*

THE demand on usual production facilities has shown many manufacturers that Shenango-Penn centrifugal castings give better service, and use less material than former methods. Our engineers have helped to solve difficult problems—have produced products formerly thought impossible with this method.

Tubular bars up to 26" O.D. and 26 ft. long are being produced frequently. Small bearings and bushings can be made economically. Flanges may be furnished and unusual shapes and sizes worked out.

Don't look on the Shenango-Penn centrifugal casting process as a substitute. It may be the *best* means to work out some of your problems. If you'd like more information on our products, facilities and a complete chart of ferrous and non-ferrous alloys available, write for Bulletin No. 143.

SHENANGO-PENN MOLD COMPANY
1509 WEST THIRD STREET, DOVER, OHIO
Executive Offices: Pittsburgh, Pa.

SHENANGO-PENN

• ALL BRONZES
• MONEL METAL
• ALLOY IRONS

What every engineer should know about

DIMENSIONAL STABILITY OF PLASTICS

When it comes to dimensional stability plastics are admittedly not in the same class with metals. If they were, they would not have many of the advantages they do have over metals and other fabricating materials. For one important example, they could not be molded with such marked production economies.

Failure to consider dimensional stability characteristics when designing a part for plastics, however, has probably been responsible for more misapplications and consequent misunderstanding of plastics than any other one factor—which explains our selfish interest in giving you an accurate picture of the relative stability of materials included in the broad and versatile Family of Monsanto Plastics.

Two of the columns in this chart give you a yardstick for measuring roughly the effect of heat. One gives you the relative water absorption of the materials covered, also important in considering dimensional stability. The fourth column lists coefficients of expansion which are important chiefly when a plastic part is to be combined with a metal part. The fifth gives you a qualitative estimate of cold flow, an index to plastic deformation under stress as distinguished from elastic deformation. The last column describes qualitatively the materials' tendency to shrink on aging under normal temperatures and humidities.

Of course, data such as this, is only illustrative. When you specify a material for a specific application you will want the most complete information you can get on every material you are considering.

When that need arises, you will find Monsanto's plastics research laboratories and technical service staff are one of the best and most comprehensive sources of engineering data on plastics in the country. Whenever we can be of service, please write: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Massachusetts.

FACTORS AFFECTING DIMENSIONAL STABILITY

	Top Safe Operating Temp., °F.	Heat Distortion Point, °F.	Water Absorption, 24 Hours, %	Coefficient of Expansion Linear per °C. x 10^{-5}	Tendency to Cold Flow	Shrinkage on Aging
RESINOX general purpose molding compounds	275	275	0.50-0.60	3.0-3.5	Negligible	Negligible
RESINOX typical electrical molding compounds	250-300	284	0.07	1.5-2.0	Negligible	Negligible
MELAMINE general purpose molding compounds	250	385	0.45-0.55	——	Negligible	Negligible
MELAMINE Electrical molding compounds	325	266	0.10-0.15	2.0-4.5	Negligible	Negligible
LUSTRON polystyrene molding compounds	160	168-176	0.04-0.06	6-8	Slight to moderate	Negligible
STYRAMIC a modified polystyrene for high frequency insulation	175	184-187	0.046	6-15	Slight to moderate	Negligible
FIBESTOS cellulose acetate molding compounds	140-180	145-260	2.0-4.0	14-16	Slight to marked	Slight to marked
FIBESTOS cellulose acetate sheets	130-150	155-175	1.5-6.0	3-15	Slight to marked	Slight to marked
NITRON cellulose nitrate sheets	130	125-175	0.5-4.0	12-16	Slight to marked	Slight to marked

NOTE: The above values, except where otherwise noted, are determined on samples conditioned and tested at 25°C. (77°F.) and 50% R.H. using standard A.S.T.M. methods. Since wide variations are possible in compounding specific formulations, the values given represent a range.

MONSANTO PLASTICS

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The Broad and Versatile Family of Monsanto Plastics

(Trade names designate Monsanto's exclusive formulations of these basic plastic materials)

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Sheets • Rods • Tubes • Molding Compounds • Castings • Vuepak Rigid Transparent Packaging Materials

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A solid steel bar half-coated with CO-RES-CO. After 20 days partially immersed in 10% *nitric acid*—more than half the unprotected steel was eaten away. The CO-RES-CO coated portion remained *unaffected*.

Data

for busy plant executives and engineers:

CO-RES-CO IS A PLASTIC solution in a hydro-carbon vehicle. And—*plastics do not corrode.*

CO-RES-CO DOES NOT OXIDIZE. It is *not* a paint. It demonstrates many times greater resistance to severe acid, alkali, salt spray and to general weathering than can be expected from any of the oxidizing paints.

CO-RES-CO EMPLOYS NO DRYERS. (To whatever extent dryers are used in the paint film, the paint is weakened exactly to that extent).

CO-RES-CO IS WIDELY USED. It is an accepted method of corrosion control in many industries and official government departments.

WRITE for further data, giving details of your corrosion and maintenance problems for specific analysis.

CORDO CHEMICAL CORP., Norwalk, Conn.

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CO-RES-CO

THE PLASTIC CORROSION RESISTANT COATING

Corrosion of Lead-Indium Alloys

Condensed from an Electrochemical Society Paper

Previous studies on the corrosion of bearing alloys have been made to determine the combined effect of chemical attack and erosion. The present investigators have studied the effect of hot lubricating oil on steel strips electroplated with lead, lead-silver, and lead-indium.

The sample panels, ½ in. by about 3 in., were cleaned, plated and hung from glass hooks in the oil, which was maintained at 170 to 180° C. (338 to 356° F.) In the case of the lead-indium samples, the temperature was kept at 155° C. (311° F.) for the first two hours to diffuse the indium into the lead.

The oil used was an uncompounded aircraft engine lubricating oil that had previously been run 395 hr. in a test engine.

The oil sludge and filtered samples of the oil were tested for lead at the end of the run. Lead was present in the sludge, probably as sulfide, and in the oil itself, probably either as colloidal sulfide or in the form of an oil soluble organic complex.

Lead plate and pure lead were corroded at rates varying from about 0.001 to 0.01 in. per year. The lead-silver coatings corroded at about the same rate as lead alone. Lead-indium coatings corroded at a much lower rate than lead alone. In some of the experiments, corrosion was completely prevented by the indium.

Thicknesses of indium of 0.0001 in. were more effective than 0.00001 in. Partial immersion of the sample and the presence of exposed iron accelerated the attack of the coatings by the hot oil.

—J. M. Freund, H. S. Linford & P. W. Schutz. Electrochemical Soc., Preprint No. 84-7, October 1943 meeting, 5 pages.

German High-Permeability Alloy

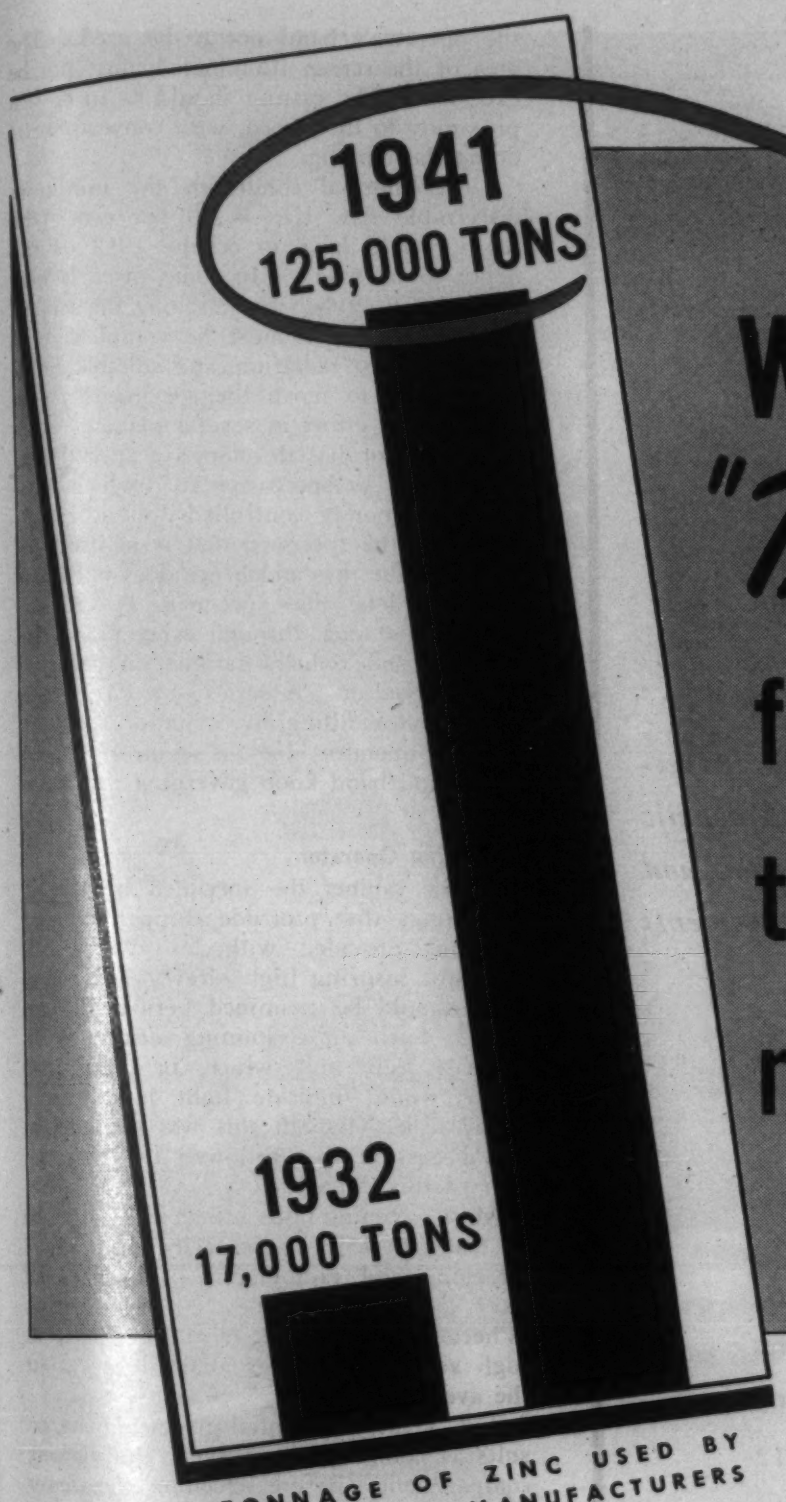
Condensed from "Archiv Eisenhüttenwesen"

To produce the highest possible initial permeability in a steel strip of great purity, experiments were made in different atmospheres and increasing temperatures. Increasing annealing temperatures had an increasingly favorable effect, while the permeability curves were lowered by annealing in hydrogen, which was contaminated by small amounts of nitrogen or carbon.

Increasing the content of nitrogen and carbon lowers initial permeability considerably, while annealing in a hydrogen atmosphere or a vacuum produces highest initial permeability by maintaining certain annealing times and temperatures. An oxidizing treatment previous to the vacuum annealing proved to be extremely advantageous.

Commercial iron-silicon alloys gave the same results, and especially with vacuum annealing initial permeabilities were obtained of the same order as those obtained with the alloys used at present with about 40% Ni.

—F. Pawlek. *Arch. Eisenhüttenw.*, Vol. 16, Mar. 1943, pp. 363-366.



TONNAGE OF ZINC USED BY DIE CASTING MANUFACTURERS

What better *"Proof of Acceptance"* for Zinc Die Castings than this ten-year record?

These figures on zinc consumption by die casting manufacturers were derived from the Year Book of The American Bureau of Metal Statistics. They are prewar years of course, and what the totals will be for 1942 and 1943 is anyone's guess.

Amazing as the increase in the production of zinc base die castings has been in the past decade, the figures tell only half the story. The other, and more important half, is the ever-widening field of application for these cost saving products—and the metallurgical achievements that have made possible zinc base die castings with thinner sections, lighter weight, more intricate coring and higher physical properties.

It is in this metallurgical field of closely controlled alloying that Anaconda has made its contribution as a supplier of highest purity zinc. For when "Anaconda Electric Zinc" is specified, purity is not only known, it is guaranteed . . . 99.99+%. 43823

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Specifications • Physical and Mechanical Property Testing and Inspection • Routine Control and Instrumentation • Radiography and Magnetic Inspection, Spectrographic and Photoelastic Analysis • Corrosion- and Wear-Testing • Examination of Coatings • Surface Measurements • Metallographic Inspection and Technique

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Fluoroscopic Inspection of Castings

Condensed from an American Foundrymen's Assn. Paper

Fluoroscopy, as applied to castings, is the visual examination of these castings by X-rays directed through the metal onto a fluorescent screen, and differs from radiography in that there is no photographic record. Sensitivity and contrast of a higher order are possible in radiography because of the exposure to the rays over a period of time, whereas in fluoroscopy the image on the screen is almost instantaneous and non-cumulative.

Fluoroscopy, therefore, is limited to light alloys of aluminum and magnesium, and in a restricted scope for these. It is less costly than radiography where films, chemicals and operator time are expensive. It is a simple and inexpensive matter to arrange a fluoroscopic set-up in conjunction with and utilizing an X-ray installation already available for radiography.

Castings having a maximum cross section of 2 in. in any part and of such shape that manipulation will allow the X-rays to penetrate every part of the specimen, so that a readable shadow is produced, are suitable subjects. Very minute flaws, such as intercrystalline porosity, cannot be detected well.

Screening demands that the specimen be maintained in continuous movement while the screen is scrutinized. It is manipulated by tongs or remote handling mechanisms, the operator's hand not to be used. The area of the screen illuminated must not be excessive. The casting should be in closest proximity to the screen, with conveyor belts doing the moving.

Under normal conditions the minimum discernible flaw size is 10 per cent (the cavity would have to occupy 10% of the depth to be seen). In some cases it may rise to 15 to 20%. In designing the screening cabinet, there must be complete protection against radiation, and suitable holding devices to move the specimens freely and without effort in several planes.

The author has developed a special machine, the "perspectrosphere," which provides a remotely controlled spherical container for the specimen that is in itself invisible to the rays and hence does not cause masking, lets the specimen be rotated through 360 deg. through every plane and position, and reduces fatigue on the part of the operator. A series of containers is provided for filling by a junior assistant. All the operator does is control a footswitch and hand knob governing the movement.

Protecting Operator

In the cabinet the specimen is held in long tongs that protrude through annular openings provided with lead-rubber diaphragms, insuring high safety. All equipment should be examined periodically for leaks. Such an examining device is an ordinary light bulb which, in a darkened room, would indicate light leaks, hence X-ray leaks (though this was disputed in the discussion that followed the presentation of this paper).

Most screening units utilize an X-ray tube of 140 to 150 kv. capacity, but where screening and radiography of bronze and steel castings are done 220 kv. is used. Where conditions are ideal, sensitivity as high as 5% or less is attained as against the average of 10%.

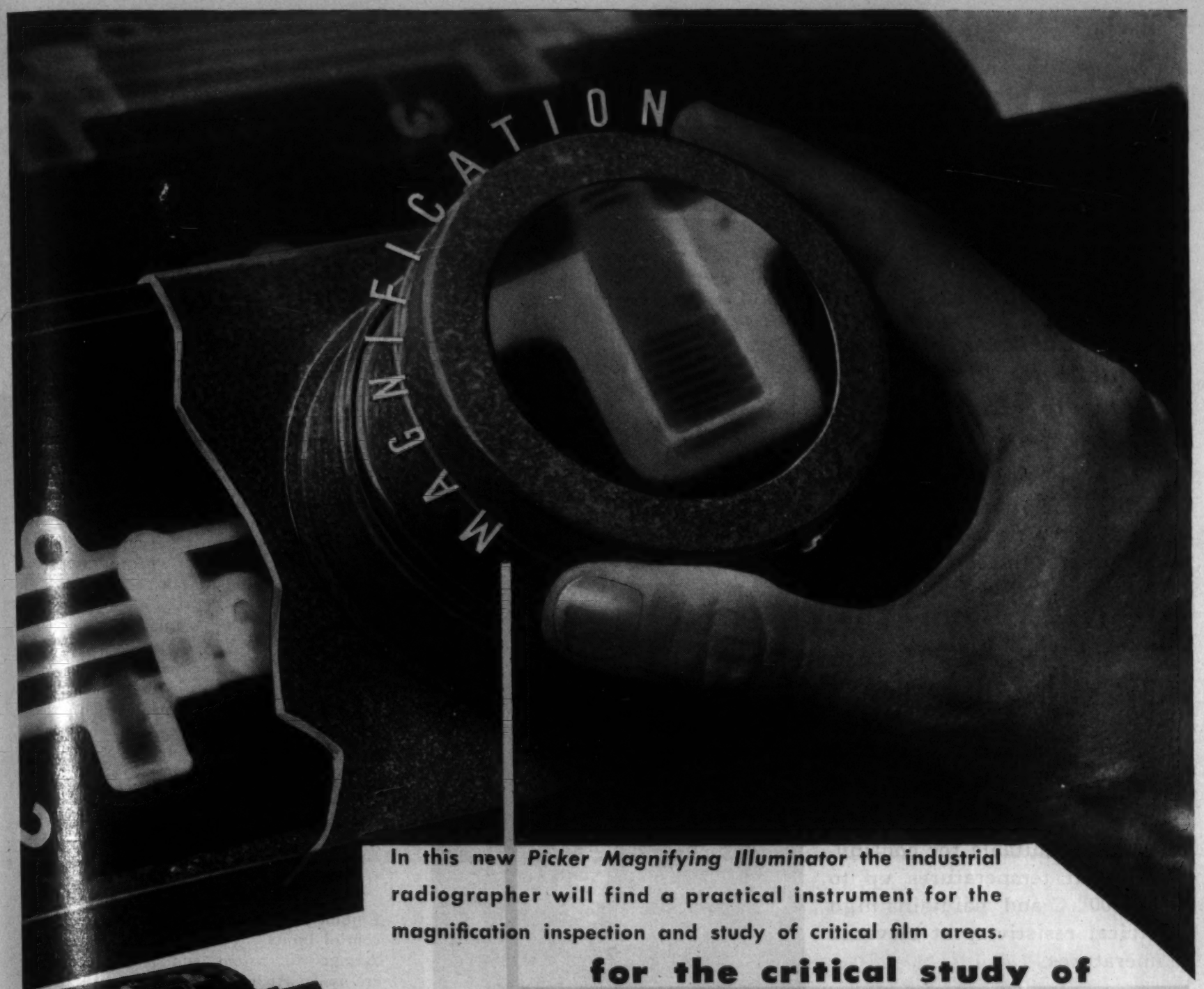
The greatest essential to maximum results is complete darkness of the viewing compartment. Before screening, the viewer should spend from 5 to 10 min. in the darkness of the viewing booth to condition his eyes to the work.

Target-screen distance should be fairly small, from 18 to 30 in. giving good results. Greater distance does not increase sensitivity while less is not practical from a mechanical standpoint of bulk of the tube housing and passage of average size castings under it.

The type of defects best discerned are blow holes, heavy metal inclusions and fairly heavy shrinkage. Screening is ineffective for minute gas pockets less than 10% of the thickness; also for fine shrinkage, internal hot tears, pinhole porosity and small sand or slag inclusions.

For highly stressed aircraft castings the maximum sensitivity obtainable by radiographic inspection is generally necessary, and acceptance inspection by fluoroscopic methods is highly questionable. Yet for unimportant low or non-stressed aircraft parts and for many industrial castings the primary requirement is absence of gross defects, most particularly in machined locations, the great majority of which can be disclosed by screen methods.

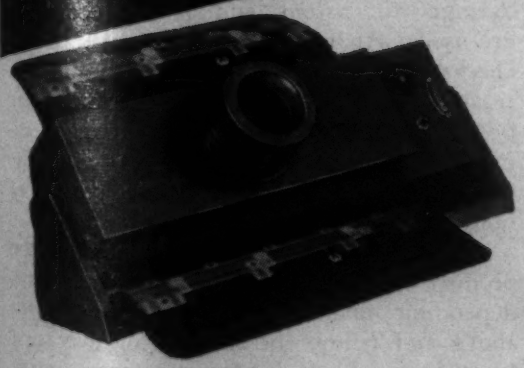
In the laboratory where radiographic in-



In this new *Picker Magnifying Illuminator* the industrial radiographer will find a practical instrument for the magnification inspection and study of critical film areas.

for the critical study of industrial radiographs

A magnifying factor of 2½X provides ample power for minute study of spot weld radiographs, or those exhibiting porosity, shrinkage cracks, gas inclusions, and similar faults. Picker Bulletin 1143 gives details, specifications, prices.



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Telescopic lens mount adjustable to individual vision...variable intensity fluorescent illumination . . . sliding baffle hood . . . adjustable viewing angle . . . takes any length film up to 14" wide...operates on AC or DC.

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Branches everywhere in U.S.A. and Canada

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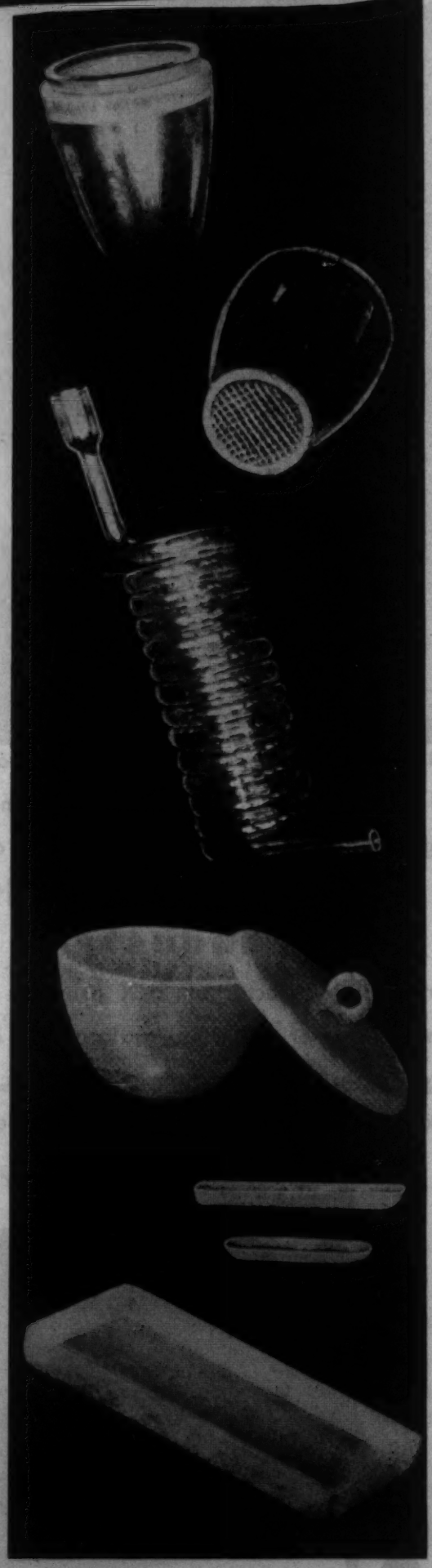

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For an increasing number of exacting analytical and research procedures Vitreosil Laboratory Ware is recognized as a highly acceptable replacement for platinum . . . and a material superior to both glass and porcelain.

Vitreosil is practically immune to the severest acid conditions, is free from metallic impurities—and possesses the highest temperature shock resistance of any ceramic material. Vitreosil Ware is suitable for continuous use at temperatures up to 1000-1100° C and maintains high electrical resistivity at elevated temperatures.

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- FLASKS
- BEAKERS
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spection involves examination of 400 to 1000 castings of many different designs daily, as much as $15 to $40 per day in film costs is saved by screening castings containing major flaws, before proceeding with radiographic routine—and fluoroscopic accessories used cost under $200.

—A. E. Cartwright. Am. Foundrymen's Assn. *Trans.*, Vol. 51, Sept. 1943, pp. 133-150.

Quality Control for Aircraft

Condensed from "The Aeroplane"

Inspection has always been one of the cardinal factors in aircraft construction. Beginning as a safety measure, it was exclusively undertaken by the Aeronautical Inspection Dept. of the Air Ministry, and later extended to certain "approved" firms. With the war an expansion of this inspection was necessary, and with only unskilled or semi-skilled personnel available, the question arose as to whether inspection, like production, could not be made semi-automatic.

The method of "statistical inspection," set up at Bristol Aeroplane Co. seeks to do this. The method has been applied to the turning shop, and will shortly be placed in a press shop also. Each inspection is recorded on a chart, showing upper and lower theoretical control limits for the dimension, upper and lower practical control limits, and upper and lower operating limits. Not less than 15% and not more than 30% of the output of each machine is so inspected, samples being taken from parts "last off."

The secret of the system lies in the formula for converting sample averages into control limits. To calculate the latter, the average dimensions and range recordings are used. At least eight consecutive sample checks are required to give a true indication. The number of sample checks having been decided upon, the full average dimension (average of averages) and the average range over the whole series of samples are ascertained.

Control limits are then calculated as the product of the average range by a constant, depending upon the number of samples above and below the average of averages. In this work four samples are always taken, and the value of the constant is .750.

For example, a dimension $\frac{3}{8}''$ $^{+.000}_{-.020}$ might have the following calculations:

Total of average dimensions of first eight checks, 2.9250″

2.9250″/8 = .3656″, average of averages

Range of first eight checks, .014″

.014/8 = .00175, average range

The constant for four samples, the quantity to be taken for the inspection, is .750.

.00175 × .750 = .0013″

Then the upper control limit is .3656″ + .0013″ or .3669″, say .367″, and the lower .3656″ — .0013″ or .3643″

When these theoretical control limits are unnecessarily close for production work, practical control limits are imposed, these being governed by the control ratio, or the ratio between the control limits and the

Radiography's still expanding range demands distinctively different types of film...

KODAK supplies 4

RADIOGRAPHY is being given so many widely differing assignments today—with so many differences in the size and shape of the parts inspected . . . in the materials used . . . in the type of information sought . . . and in the radiation employed—kilovoltages from 5 to 1000, as well as gamma rays . . . that one type of film is no longer enough for the work. Kodak supplies four distinctly different types—with individual combinations of characteristics designed specifically for the exacting requirements of the industrial field . . .

Kodak Industrial X-ray Film, Type M Primarily for million-volt work. This newest Kodak Film has extra fine grain, high contrast, and is particularly effective for most million-volt work . . . for aluminum and magnesium alloys at average voltages . . . and, for general use, where highest definition is desired and high film speed is not required.

Kodak Industrial X-ray Film, Type A Primarily for light alloys at lower voltages. A fine grain, high contrast film, with higher speed than Type M. Particularly suitable for light alloys at lower voltages and for million-volt radiography of thick steel parts.

Kodak Industrial X-ray Film, Type F Primarily for the radiography, with calcium tungstate screens, of heavy steel parts. Has the highest available speed and contrast with calcium tungstate intensifying screens. Also used for gamma radiography—direct and with lead-foil screens.

Kodak Industrial X-ray Film, Type K Primarily for the radiography, direct or with lead-foil screens, of lighter steel parts. Has the highest available speed in direct x-ray exposure . . . when used with lead-foil screens at higher voltages . . . and, for heavier parts, with gamma rays.

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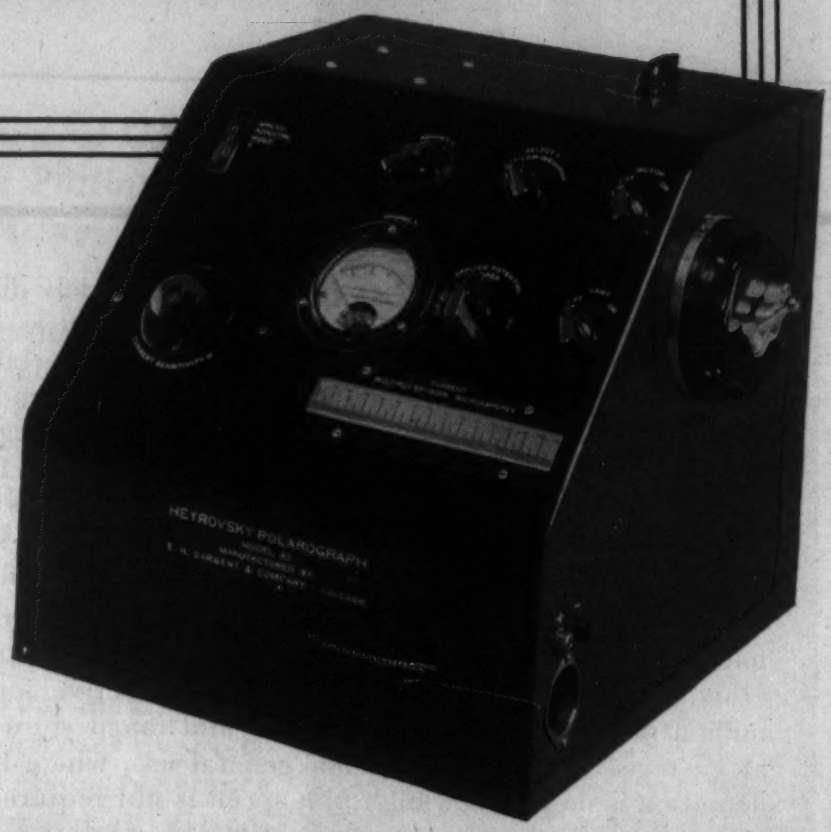

The application of the polarographic method of analysis expands steadily. Some of the analyses being made with the Heyrovsky Polarographs now in use include the analysis of brass; of steel and iron; of lead, magnesium, nickel, and zinc alloys; of metallic impurities in aluminum; of lead and zinc in paints; of major constituents in plating solutions; and the differentiation of waters.

In the industrial health field, the Polarograph is being successfully used for such important analyses as the detection of incipient lead poisoning. The sensitivity, simplicity and speed of the polarographic method for determination of lead in urine permits complete and periodic examination of plant personnel at low cost without the need of highly trained operators.

Accuracy; rapidity; the possibility of detecting and identifying minute quantities and of making simultaneous determinations of several components; small sample requirement; preservation of sample; and permanent photographic recording of every analysis are some of the reasons why the Heyrovsky Polarograph is becoming so widely accepted.

The procedures established thus far by no means define the field of polarography—the perfected instrumental system of the Heyrovsky Polarograph creates unlimited possibilities for analytical and research applications.

A bibliography of more than 700 papers dealing with the polarographic method of analysis and a booklet discussing the Polarograph and polarographic analysis are available without charge on request.

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operating limits. The ratio permissible is

$$\frac{1}{\sqrt{n}},$$

when n is the number of samples. Thus, with four samples the control limit spread must not exceed one-half the operating limit.

The advantage of this system is that it predicts when trouble may be expected. As the machine turns out parts varying beyond the control limits, the record on the chart calls it to the attention of the inspection and supervisory staff.

In operation, the system has reduced the amount of scrapped parts from 3% to .75%, and corrections from 7% to less than 3%.

—*Aeroplane*, Vol. 65, July 2. 1943, pp. 12-13.

Plastic Flow and Failure

Condensed from an American Society for Metals Paper

Although a knowledge of the plastic and rupture properties of metals is of the utmost importance in many applications, these properties have not received their fullest fundamental considerations.

On the stress-strain curve, the elastic state has the attributes of linearity and reversibility; the plastic part of the curve may be linear (its slope is everywhere much less than that of the elastic state), but its essential attribute is irreversibility. The elastic state of an idealized isotropic material is completely specified by Hooke's law.

Although plastic behavior has not been successfully systematized into a set of laws corresponding to Hooke's for the elastic state, two fairly successful systems have been proposed: Mohr directs attention to the planes of maximum shearing stress, Von Mises to certain quadratic invariants of stress and strain. These two systems may be regarded as complementary.

Some metals require less stress for continuance of plastic flow than for its initiation, so there is a sudden drop at the incidence of plastic deformation. The magnitude of maximum stress in the elastic state (upper yield point) is very sensitive to the shape of the specimen, the axiality of loading, and to the surface finish.

A heterogeneous deformation then starts and fluctuates around a constant value until all the material in the gage length has been traversed by deformation bands. The mean stress of this heterogeneous deformation is the lower yield point; it is much more sensitive to the rate of deformation and temperature than is the strain hardening curve. Plastic deformation of polycrystalline aggregates involves plastic deformation of the individual grains and a displacement of material on one side of the grain boundary relative to material on the other side.

The yield stress depends on whichever resistance is lower. According to Mohr, the plastic deformation begins when the maximum shear stress exceeds a critical

(Continued on page 212)

WHERE ENDURANCE COUNTS..

G-E X-Ray Units Check Inside Strength at War Production Speed

There's no argument—America's fighting machines must be built to endure. Every possible weakness must be checked and eliminated. And fast. The result must be tough, equipment built in the shortest possible time, and with the smallest possible waste—a minimum of rejects. That's where x-ray comes in.

X-ray examination can assure improved welds and castings—castings that will measure up to the high standards demanded in war time production, welds that will withstand severe shock and stress. For with x-ray, it is possible to "see inside"—to examine the interior structure and not only find hidden faults, but study their location and character so that they may be avoided in the future.

Yes, x-ray has found many wartime jobs in industry, and G-E X-Ray units—with transformers, tubes, controls, and mountings all designed expressly for industrial service—are doing the great majority of those jobs.

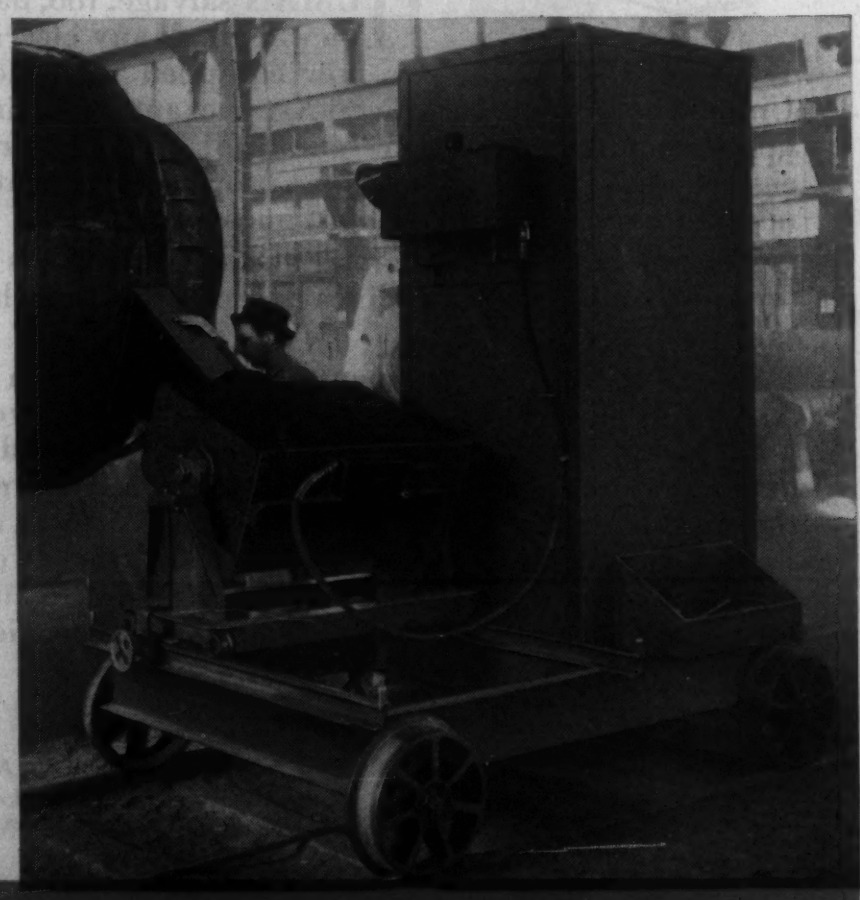
An ideal unit for use on castings and weld work where widely varying radiographic positions require frequent changes in the vertical height of the x-ray tube head is the G-E Motor-Operated Jib Crane Unit with either G-E Model OX-200 (200,000-volt) or G-E OX-250 (250,000-volt) x-ray apparatus. Its wide range of vertical and horizontal travel and the degree of angulation and rotation of the tube head makes positioning an easy accurate procedure.

Also available with the OX-200 or the OX-250 is the G-E Mobile Jib Crane Unit. Mounted on a pneumatic-tires chassis it can be moved easily to any large inspection job. This unit also provides an unusual degree of flexibility and permits fast, exact positioning for practically all types of radiographic inspection.

For weld shops not equipped with concrete or other smooth floors, G-E X-Ray designed the Flange-Wheel Truck Unit, for use with the G-E Model OX-200 or the OX-250.

For the complete story about G-E Industrial X-Ray Units or if you wish the services of a G-E Industrial X-Ray Engineer, write or wire, today; to General Electric X-Ray Corporation, 2012 Jackson Boulevard, Chicago 12, Illinois; Department NN21.

G-E Flange-Wheel Truck Unit



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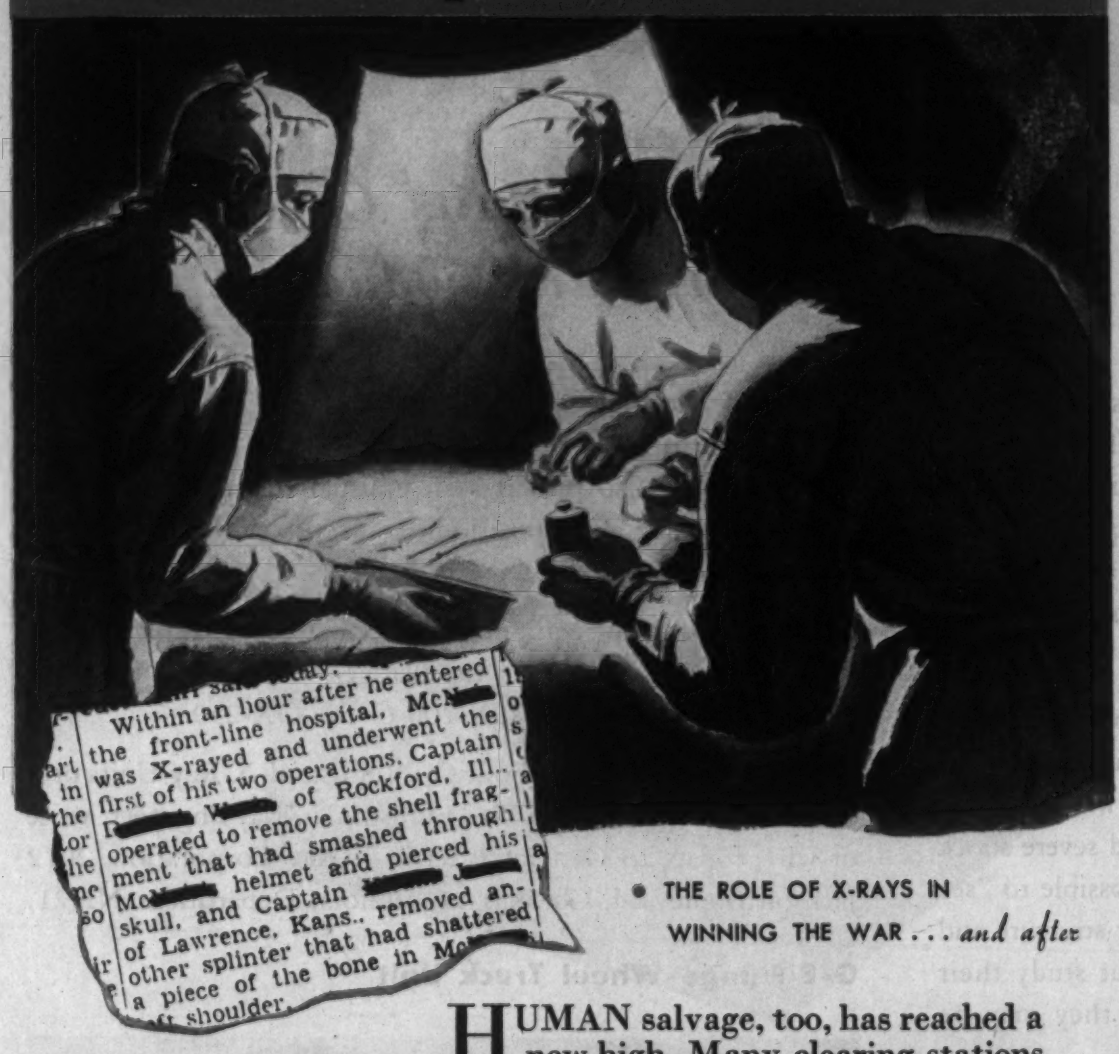


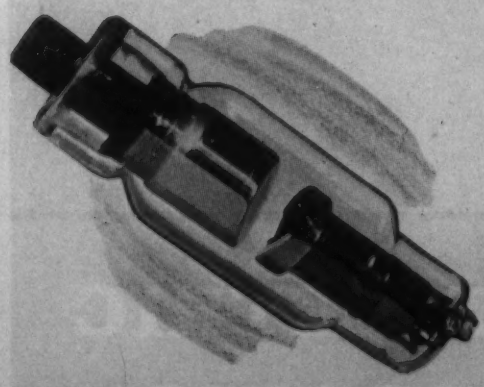
Within an hour after he entered the front-line hospital, Mc[redacted] was X-rayed and underwent the first of his two operations. Captain [redacted] of Rockford, Ill., operated to remove the shell fragment that had smashed through [redacted] helmet and pierced his skull, and Captain [redacted] of Lawrence, Kans., removed another splinter that had shattered a piece of the bone in Mc[redacted] shoulder.

• THE ROLE OF X-RAYS IN WINNING THE WAR . . . *and after*

HUMAN salvage, too, has reached a new high. Many clearing stations are now equipped with mobile X-ray Units. The wounded are given X-ray examination immediately upon reaching the station—extent of injury determined, foreign bodies located, insuring proper treatment with the minimum of delay and without guesswork.

This speedy wound analysis and treatment has saved hundreds of young American lives and put them on the road to a safe recovery.

The war-time developments and extension in the use of X-rays will not be forgotten when the war is over. The improvements in apparatus and techniques, the discovery of many new uses for this miracle of modern science, will result in the employment of its magic not only in treatment and diagnosis of the sick and injured, but also for a vast variety of industrial applications as well. The further unlocking of Nature's secrets in many fields awaits the application of this scientific tool.



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value; Von Mises states that it begins when the elastic shear energy exceeds a certain critical value.

Experimental results for yielding under combined stresses show that copper and aluminum obey Von Mises's law almost precisely. A divergence in the case of mild steel is believed due to the anisotropy of thin walled tubes.

Stress-Strain Curves

Results on the relation between stress and strain during plastic flow lie between the curves associated with the two theories but are much closer to the one predicted by Von Mises.

The true stress-strain associated with uniaxial tension becomes linear after a small initial distortion, provided the natural rather than the conventional strain is used. The stronger the steel, the larger its increase in strength due to a given strain. There is a general increase in the rate of strain hardening with the carbon content. Strain hardening is, in fact, essentially isotropic.

Compared with the Mohr and Von Mises theories, the strain hardening for simple shear agrees fairly well with that for tension for very small values of strain, but soon becomes much less than that for tension. The difference is believed to be due to the fact that reorientation and elongation of microscopic cracks in simple shear counteracts the strain hardening of the matrix.

Many phenomena previously inexplicable are shown to be explainable in a qualitative manner by a single type of imperfection, namely, microscopic cracks. The rupture of a tensile specimen will probably occur when the average maximum tensile stress in the specimen exceeds the critical value determined by the average size of these regions of weakness. It is suggested that as deformation proceeds in pearlitic steels, the brittle cementite plates break and the resulting transverse cracks spread through the matrix.

Failure in shear should occur in a material containing cracks of a given size when the shearing stress reaches a value such that the spreading of a crack will relieve sufficient shear strain energy to decrease the net potential energy.

—C. Zener & J. H. Hollomon. A. S. M. Preprint No. 9, Oct. 1943 meeting, 53 pp.

Carbide-Forming Elements in Steel

Condensed from "Archiv Eisenhüttenwesen"

The effect of the carbide-forming elements titanium, vanadium, chromium and molybdenum on the elastic limit of steel samples in various stages of heat treatment was investigated. After cooling in the furnace from 930°C. (1700°F.), the elastic limit disappears with the complete binding of carbon to special carbide. The transition from one type of flow limit formation to the other takes place gradually in chromium and molybdenum steels, and jerkily in titanium and vanadium steels.

After cooling in air conditions in titanium steels are similar to those after furnace cooling, but the vanadium steel shows, even after complete binding of the carbon, an unstable flow curve in a certain alloying

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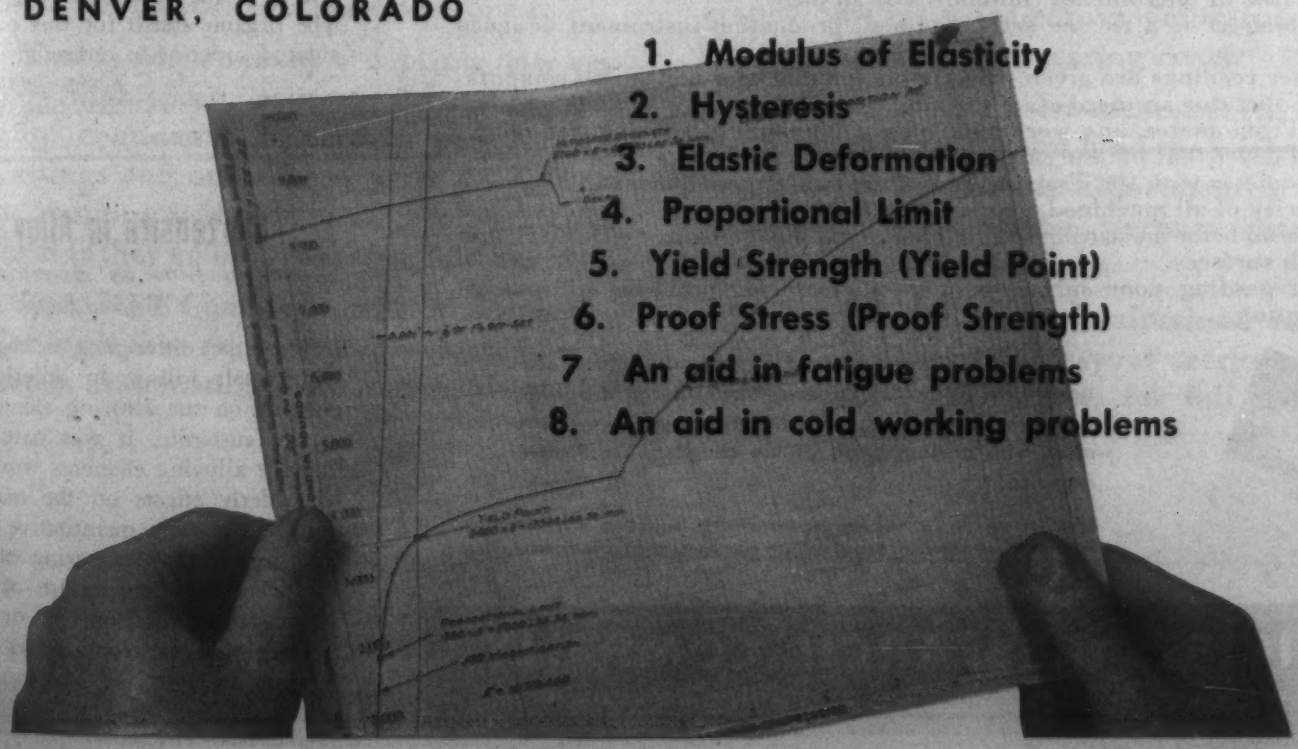

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IN WAR plants all over the country, Profilometers are at work measuring the roughness of machined surfaces—on aircraft engine parts, shell dies, bearings, and thousands of other parts that go into the machines with which we wage war.

Demands of war have made the Profilometer* a useful gaging device wherever machined parts are produced. Why? Because the Profilometer, by providing a means of *measuring* surface roughness, enables uniform *control* of surface quality.

In time of war, control of surface finish is of utmost importance. Time is short . . . the highest production must be maintained. Materials are scarce . . . waste must be kept at a minimum. The Profilometer is helping to meet these requirements.

☆ Profilometer inspection on intermediate finishing operations will greatly facilitate final finishing of the part to specified dimensions.

☆ Profilometer readings will show whether parts meet surface-roughness specifications.

☆ Profilometer inspection can prevent waste of valuable time incurred by finishing parts *beyond* specifications.

☆ Profilometer inspection can prevent waste of materials through needless scrapping of rejections that can be reworked.

Thus has the Profilometer proved its value in war-production inspection in the saving of materials, time, and money. There is a moral here, too, for postwar planners.

What is the Profilometer?

The Profilometer is an electronic instrument which indicates the average roughness of a surface in microinches (millionths of an inch).

The Profilometer is a rugged self-contained, production instrument designed for use in the shop.

Profilometer readings are given directly on the dial of a meter—no computations by the operator are needed.

With the Profilometer, any workman, with a minimum of training, can obtain accurate and consistent measurements.

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*Profilometer is a registered trademark indicating Physicists Research Company's brand of surface-roughness gaging equipment.

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range. It can be concluded from this that vanadium carbide, just as iron carbide, can produce a pronounced flow limit.

The results of tempering experiments show that, for the elastic limit, not so much the chemical nature of the carbides but their distribution is the determining factor. The pronounced flow limit in the vanadium steels appears only at a certain critical degree of distribution of the carbide particles, while in the hypo- and hypercritical degree a smooth flow line exists.

—K. Dies. *Arch. Eisenhüttenw.*, Vol. 16, Mar. 1943, pp. 333-340.

Coating Aids Magnetic Inspection

Condensed from "Industrial Finishing"

In the magnetic inspection of iron and steel parts, it has been a common practice to electroplate the parts with a flash of cadmium in order to provide a white background with good color contrast, on which the collection of the magnetic particles on flaws in the base metal can be readily observed.

As a result of the present severe shortage of cadmium, it became necessary to find a substitute material for this purpose. Several dyes that were tried were unsatisfactory. Color contrast was poor because of the translucence of the dyes, and the dyes tended to dissolve in the oil in which the magnetic test particles were suspended. On test inspections, only half as many flaws were noted as when a cadmium background was used.

A white organic metal primer was found to be satisfactory in all respects. It was noticed that certain details should be followed in order to obtain the best results. The parts should be sandblasted clean, following which they are sprayed with the primer. A light application of the primer, so thinned that the appearance of the fresh film is wetly translucent without strong evidence of pigmentation, gave the best results.

After the inspection is completed, the primer may be removed by sandblasting if the part is to be electroplated, or it may be left on if the part is to have a paint finish. The organic finish for this purpose is considered superior to cadmium in all respects.

—G. C. Close. *Industrial Finishing*, Vol. 19, Sept. 1943, pp. 37-42.

Martensite in Alloy Steels

Condensed from an American Society for Metals Paper

Since the differences in the S curves of alloy steels follow an orderly change, depending on the alloying elements dissolved in the austenite, it was natural to expect that the alloying elements would have similar orderly effects on the martensite reactions. The only quantitative results available showed that increasing carbon markedly lowers the temperature of the start of the martensite reaction (Ms or Ar'' point.)

Tests were made on a series of steels with varying amounts of manganese (1-5%), silicon (1%), nickel (1-5%), chromium

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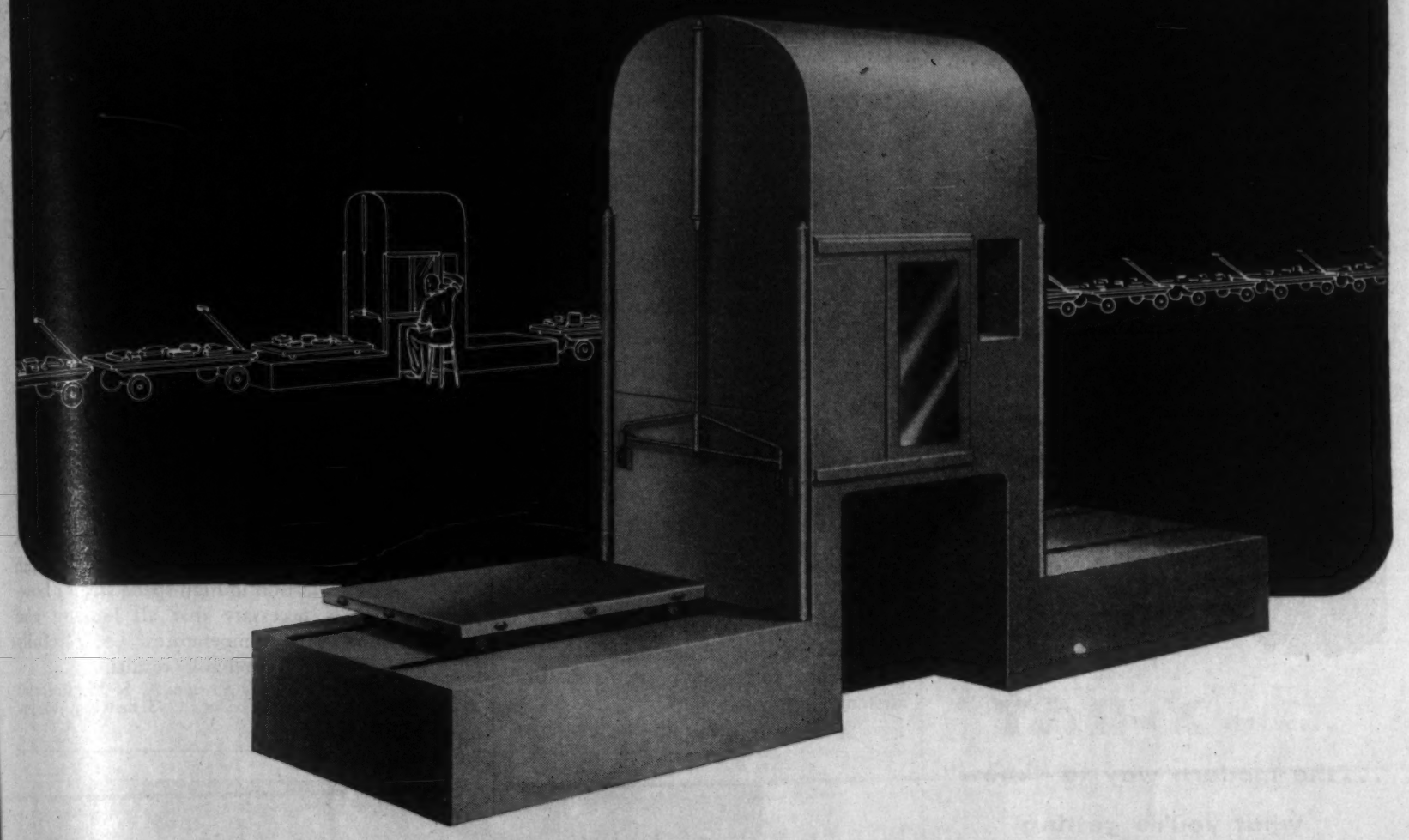

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(1-5%), molybdenum (1-5%), tungsten (1-5%) and one heat with nickel and chromium (3% Ni-1% Cr). The carbon content was held constant at about 0.5% to avoid changes in the composition of the austenite by precipitation of ferrite or the presence of undissolved carbides. The Ms determinations were made by the Greninger-Troiano quench-temper metallographic procedure.

The austenitizing temperatures were based on the solubilities of the carbides and were high enough to ensure complete solution of the carbides. It was found that as long as the temperature is sufficiently high for complete solution of the carbides, the austenitizing temperature has a negligible effect on the Ms point.

The data showed that for the steels studied all elements tend to lower the temperature of the martensite reaction. Carbon is by far the most effective, the order of the elements from most to least effective being manganese, chromium, nickel, silicon, molybdenum and tungsten (the latter three are about equal). The decrease in the Ms temperature appears to be directly proportional to the amount of the element in the steel.

The following formula was set up to predict the Ms temperature: Ms in °F = 930—570 C—60 Mn—50 Cr—30 Ni—20 Si—20 Mo—20 W. It is satisfactory for low alloy steels, provided the austenitizing temperature used is one at which all carbides are completely dissolved in the austenite.

The position of the Mf points (completion of the martensite reaction) is rather uncertain, but they are generally about 325—475°F. below the Ms points, with the spread between Ms and Mf points being greater for the elements that are most effective in depressing the Mf point, namely, manganese, chromium and nickel.

Since carbon has such a marked effect on the Ms point, it is clear that the martensite reaction can be used to measure the carbon content in steel and, therefore, the decarburization. All that is necessary is that the steel be heated to a temperature at which all carbides are in solution and that the austenite thus formed be cooled sufficiently rapidly to the martensite temperature to avoid any high temperature transformation. By use of the procedure outlined above, the carbon content can be measured to about 0.02%.

A modification can also be applied to high alloy steels in which the carbides are not completely dissolved at any austenitizing temperature, provided a constant austenitizing temperature is used. Data on two high-speed steels (18-4-1 and 5-4-4-1) with varying carbon content showed a linear relationship between the Ms temperatures and the carbon contents.

Examples are given of the use of this modified method in measuring the depth of decarburization in high-speed steels; however, it is necessary that all heating and transformation temperatures be carefully controlled to get reliable results.

—P. Payson & C. H. Savage, A. S. M. Preprint No. 11, Oct. 1943 meeting, 16 pp.

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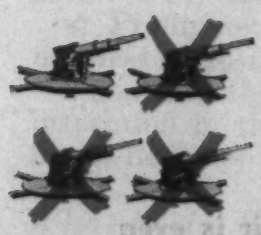

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More Information? See page 19

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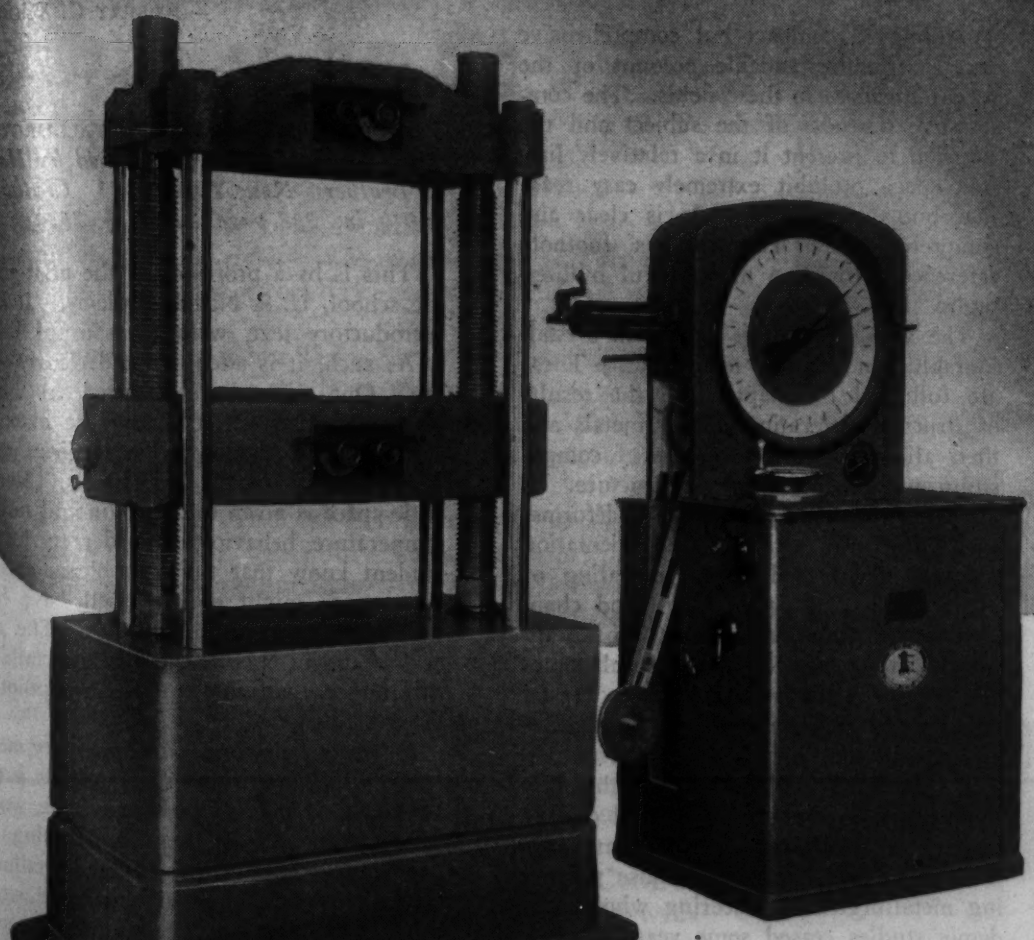

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FOR METALLURGICAL ENGINEERS

Structure of Metals

STRUCTURE OF METALS. *By Charles S. Barrett. Published by McGraw-Hill Book Co., Inc., New York, 1943. Fabrikoid, 6¼ x 9¼ in., 567 pages. Price $6.00.*

This book is the most recent and a most worthy addition to the excellent series on metallurgy and metallurgical engineering being published under the editorship of R. F. Mehl.

Only a few years ago a book on the structure of metals would have dealt exclusively with microstructure; the present work contains only a dozen photomicrographs and is chiefly concerned with the finer, more basic structure revealed principally by X-ray diffraction. The book is fundamentally different in approach from the current standard works on "physical" metallurgy, but it will probably start a new custom and serve as a model for the books that are to be written in the next two decades. It is the first work of a metallurgist, intended primarily for a metallurgical engineering audience, that has taken proper cognizance of the great strides made by physicists and mathematicians in explaining the theory of the solid state, and to make use of this knowledge throughout the text instead of appending an undigested chapter or a long footnote.

Old line metallurgical engineers will claim that the text reads more like a book on physics than on metallurgy, yet it is now clear that further advances in the utilization of metals will be made principally through the application of this type of knowledge. Those to whom space lattices, pole figures—and now energy levels and zone theory—are mysteries should be most grateful to the author for providing in compact but comprehensive form an understandable account of the recent advances in these fields. The comparative newness of the subject and the decision to present it in a relatively limited space prohibit extremely easy reading, but the author's style is clear and comprehensible. The copious footnote references provide a most useful bibliography.

The first 10 chapters deal with crystallography and X-ray techniques. These are followed by chapters on the results of structure determination for metals and their alloys, and the influence of composition and other factors on structure. A great deal of attention is paid to deformation, slip bands, and preferred orientation resulting from cold work, annealing or other causes. A particularly good chapter is that on age hardening. To the appendix are relegated some useful tables relating to X-ray wave lengths, crystal geometry, and some more abstruse material on intensity and Fourier analysis.

Dr. Barrett's book is to be highly recommended as a text for advanced college courses in metallurgy, and will serve admirably to bring up-to-date those practicing metallurgical engineering whose academic studies ceased some years ago.

—CYRIL S. SMITH

Radiographic Inspection

RADIOGRAPHIC INSPECTION OF METALS. *By Otto Zmeskal. Published by Harper & Brothers, New York, 1943. Cloth, 5 x 7¾ in., 150 pages. Price $2.75.*

This small text is certainly of value to the student, but the result is just about what one would expect from an effort to cram the entire science of an art in 132 small pages. The material assumes a staccato tone as the reader is jolted by a series of facts delivered ack-ack style. The author says in his preface that he will make no attempt to discuss physical theory or X-ray apparatus, from which statement he plunges directly into a discussion of physical theory and X-ray apparatus.

In six pages, the reader is hustled from the discovery of X-rays, through the subject of spectral emission, and out by the way of gamma-ray production. This is rather a discouraging start, because the multitude of facts displayed, without any explanation attached, would tend to a beginner to be merely a meaningless assembly of unrelated data. Furthermore, some of the information is inaccurate, or at best debatable.

On the brighter side, however, Dr. Zmeskal exhibits in many ways his undoubted ability, both as metallurgist and teacher. His chapter on radiographic practice should be kept at hand by every student and consulted liberally as various jobs come along. Likewise, the section dealing with radiograph interpretation could well be used as a standard by any X-ray laboratory.

Dr. Zmeskal's book quite definitely should be read by every student, inspector, and engineer intending or preparing to deal in any way with the radiographic inspection of metals.

—ROBERT C. WOODS

Physical Metallurgy

PRINCIPLES OF PHYSICAL METALLURGY. *By Frederick L. Coonan. Published by Harper & Brothers, New York, 1943. Cloth, 6¼ x 9¼ in., 238 pages. Price $3.25.*

This is by a professor in the post-graduate school, U. S. Naval Academy. It is an introductory text, written on usual lines.

As such, it is adequate and clearly written. One might have expected, in a book published in 1943, a little more extensive discussion of hardenability, leading up to some mention of the N.E. steels. Since a little space is given to corrosion and to high temperature behavior, in order to let the student know that those problems exist, a few words might equally well have been devoted to fatigue and notches. The general treatment is from the purely metallurgical, rather than the engineering, point of view.

However, any course in elementary metallurgy will have lectures as well as a text book, in which case this text book would serve, with the lectures emphasizing the engineering implications of the metallurgical principles. For home study without an instructor, a text written on an engineering basis would be more easily assimilated.

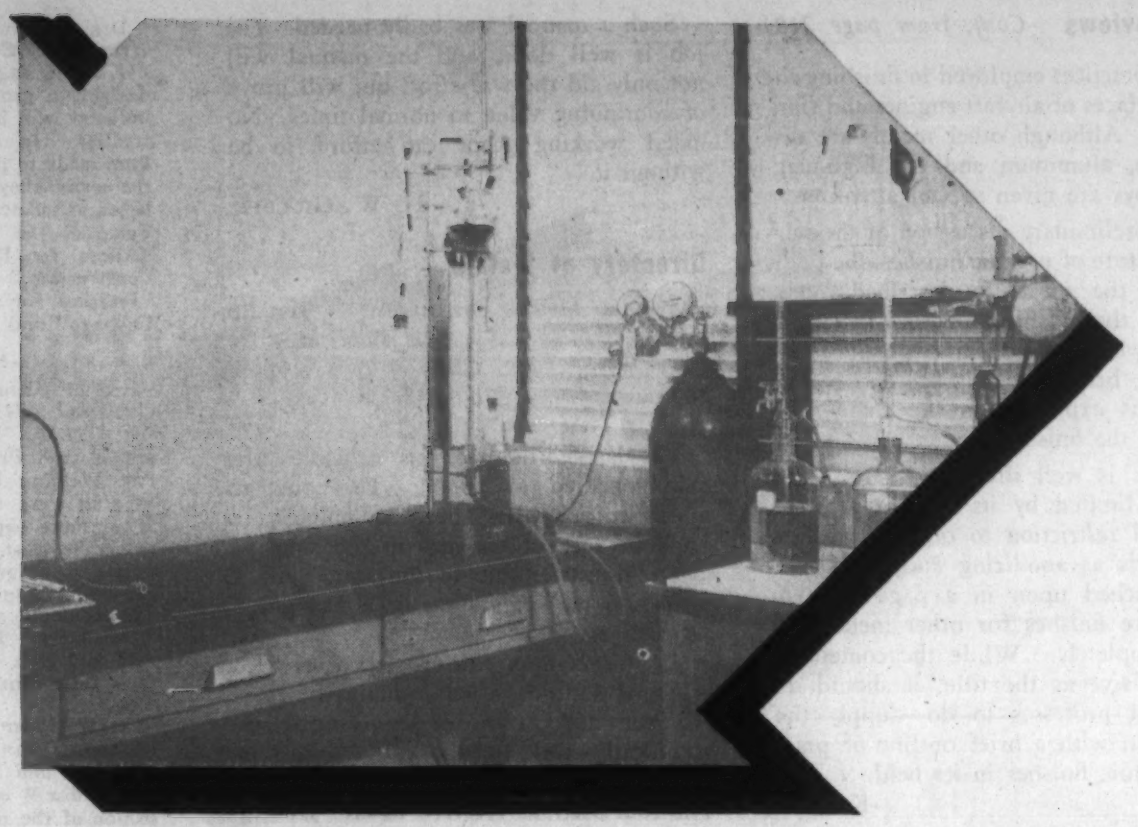
—H. W. GILLETT

Aircraft Engine Finishes

AIRCRAFT ENGINE AND METAL FINISHES. *By Myron A. Coler. Published by Pitman Publishing Corp., New York, 1942. Cloth, 5¼ x 8¼ in., 128 pages. Price $1.50.*

Designed to help the reader who has problems to be solved but does not possess a technical knowledge of finishing, this book "provides a brief description of current

(Continued on page 220)



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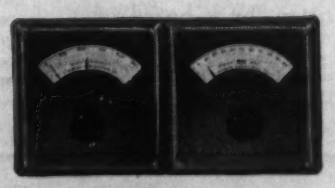

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(Book Reviews *Cont. from page 218)*

American practices employed in finishing the exterior surfaces of aircraft engines and similar parts." Although other metals are discussed also, aluminum and the high-magnesium alloys are given special attention.

After a preliminary discussion of the purpose and nature of organic finishes, the preparation of the metal is described. The readying of the finishing material for application is covered in a separate chapter. Use of spraying, brushing, dipping, and baking techniques is explained in the chapter on applying of the finish.

The book is well illustrated. Its scope is severely limited by its size, and by its self-imposed restriction to organic finishes. Such subjects as anodizing and chromatizing are touched upon in a page or two, while surface finishes for other metals are ignored completely. While the content is not as inclusive as the title, it should do just what it professes to do—supply the practical man with a brief outline of practices in organic finishes in its field.

—K. Rose

Salvage Manual

Salvage Manual for Industry. *Published by Technical Service Section, Industial Salvage Branch, Salvage Division, War Production Board, Washington, D. C., 1943. Cardboard, 5¾ x 9¼ in., 243 pages. Price (through Government Printing Office, Washington) 50c.*

Something of how to prevent the production of scrap, and much on practical, proven means for segregation, direct use, or sale of scrap, are included. The organization necessary, as well as the techniques involved, are clearly discussed.

Non-metallic materials, oils, paints, plastics, wood, etc. are given some space, but the main emphasis is on metals. Spark testing and other sorting methods, crushing and briquetting of turnings, tool salvage, etc. are discussed. Case histories record important savings and important unearthing of dormant scrap, in large and small plants.

Scrap classifications are conveniently summarized. The whole manual is simply and clearly written, by a board of seven editors with a good understanding of the subject.

Such a manual was badly needed. The job is well done, and the manual will not only aid the war effort but will prove of continuing value in normal times. No metal working plant can afford to be without it.

—H. W. Gillett.

Directory of Metals

Standard Metal Directory — 9th Edition. *Published by Atlas Publishing Co., New York, 1943. Cloth, 6¼ x 9¼ in., 705 pages. Price $10.00.*

The last edition of this valuable directory appeared in 1940. This one, the ninth edition, has been completely revised because of changes in the steel and metal industries due to the war. All information and data have been brought up to date.

As in previous editions, there are four principal sections which contain the names of over 7000 companies, arranged geographically and alphabetically. Pertinent facts regarding each company are given. The four sections referred to are: Iron and Steel Plants; Ferrous and Non-Ferrous Foundries; Metal Rolling Mills; and Smelters and Refiners of Non-Ferrous Metals.

Supplementing these four sections there are special lists of manufacturers and distributors of various products; smelters and refiners; die casting plants; scrap metal dealers; and so on.

To round out the coverage of the directory, three new lists have been added: (1) Fabricators of structural steel and so forth; (2) lists of airplane manufacturers; and (3) merchants who specialize in used structural steel products.

As a reference for the steel and metal industries, this directory should find wide use.

—E. F. Cone

Other New Books

Bibliography of Beryllium Copper. *Published by Instrument Specialties Co., Inc., Little Falls, N. J., 1943. Paper, 8¼ x 9½ in., 12 pages. Free to those interested.* This little pamphlet gives a running account of the principal articles and discussions on beryllium-copper from the year 1926 to July 1943. Published information on this alloy is rather meager as well as widely scattered. This compilation is valuable in that it brings together in convenient and compact form important data for engineers interested in this material.

Die Casting for Engineers, *Published by the New Jersey Zinc Co., New York, 1942. Cloth, 6¼ x 9¼ in., 148 pages. Price $1.00.* Those desiring a general discussion of the die casting industry will be interested in reading this brief treatise. In its preparation every effort has been made to present an impartial analysis of all the many alloys in use. The discussion should be of assistance to both students and engineers. Some of the chapters cover such subjects as "Alloys for Die Casting," "Elements of Die Construction," "Die Casting Applications," "Finishes for Die Castings," "Design of Die Castings" and so on.

Studies in Arc Welding. *Published by the James F. Lincoln Arc Welding Foundation, Cleveland, 1943. Cloth, 6 x 9 in., 1295 pages. Price $1.50.* In the 1940-42 Industrial Progress Award Program of The James F. Lincoln Arc Welding Foundation, many papers on arc welding were submitted. This book reproduces 98 of these papers. This assemblage is pointed to as the most comprehensive and complete collection of design studies on arc welding published since the Foundation's first volume in 1939. The contents are arranged in 9 sections with 98 chapters. Each section covers a particular field and each chapter a specific design subject. It is fully illustrated with 1007 illustrations.

Steel Products Manual. *Section 8.* Hot-Rolled Carbon-Steel Bars. *Published by American Iron and Steel Institute, New York, 1943. Paper, 6 x 9 in., 72 pages. Price 25c.* In this section of the manual the following are some of the main topics discussed: Standard Carbon Steels, NE Carbon Steels, Nonstandard Steels, Method and Sampling, Manufacturing Tolerances, Glossary of Manufacturing Terms, and so on. It contains considerable data used to those interested in bars. Originally issued in 1940, the latest of these revisions is June 1943.

Radiography of Materials. *Published by Eastman Kodak Co., X-ray Div., Rochester, N. Y., 1943. Cardboard, 6 x 8½ in., 100 pages. Free upon request.* To provide a concise elementary description of the basic physical and chemical principles of radiography as applied to the non-destructive examination of materials is the purpose of this book. The significance of conditions disclosed is not discussed. The book might have borne the title "Photography and Radiography," since emphasis is on the exposure and processing of films. Prominent in the contents are: Industrial Radiography, X-Ray and Gamma Rays, The Radiograph, Intensifying Screens, X-Ray Films and Their Use, Processing, etc. A bibliography of books and articles is included.

Patent Law. *By Chester H. Biesterfeld. Published by John Wiley & Sons, Inc., New York, 1943. Fabrikoid, 5¾ x 8¼ in., 225 pages. Price $2.75.* This book is described as the outgrowth of a series of lectures on the substantive patent law. This compilation of these lectures is aimed to be helpful not only to students but also to others who are more or less regularly confronted with questions of patent law and practice. An endeavor is made to explain this basic principle or rule underlying the subject under discussion and to illustrate by the citation of leading cases and by quotation therefrom of pertinent sections. There are 21 chapters, a bibliography and a table of cases.

RAY PROOF

X-RAY PROTECTION is not a Guessing Game

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As the oldest organization in the field, Ray Proof engineers have been trained to design X-Ray protective equipment of the most complicated nature. With the increasing importance of X-Ray as a tool of industry, we take extreme pride in having made many vitally important contributions to its successful use . . . our designs of special equipment to speed production in and out of the X-Ray department have earned us that which we value most—a reputation to perform successfully.

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X-Ray Protection — Light Proofing

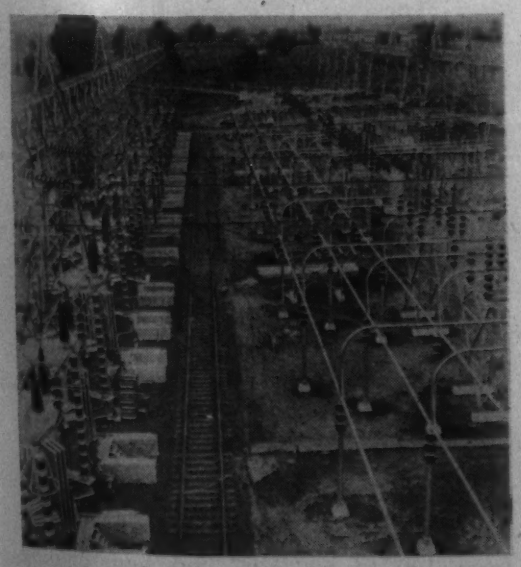
METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Wrought Iron for Carrying Current

Wrought iron pipe serves as buses at the Bonneville power project, thus saving copper and aluminum. This is said to be the first recorded instance in which this 8,000-year old metal has been used for such current-carrying mains, states *A. M. Byers Co.*, Pittsburgh, maker of wrought iron products.

At 115 and 230 kv. the iron pipe carries current satisfactorily, the largest size needed



being a 4-in. pipe. Capacity is increased, if necessary, by slotting the pipe along its length to break the ferrous loop, and by coating the pipe with dull black paint to increase heat emissivity.

Among other advantages are: It has a high modulus of elasticity, permitting long spans and good corrosion-resistance; it is welded easily; it expands less than copper or aluminum, necessitating fewer expansion joints; it costs less; and welded buses reduce corona formation.

At Bonneville the protective asphalt varnish was removed; it was cleaned with an abrasive and painted with one coat of synthetic red lead and two coats of aluminum paint.

Press for Powdered Metals

An improved model of press for high-speed production of powdered metal parts, Steatite and other "dry-mix" ceramics is announced by the *F. J. Stokes Machine Co.*, Tabor Road, Olvey P. O., Philadelphia. Known as "R" model, it is also recommended for debulking chemicals, compressing food specialties, etc.

Pieces up to 3 in. diam., with a die-fill of 2⅝ in., are compressed at rates of 15 to 45 per min. Pressures up to 20 tons are applied from both top and bottom, with pressure adjustments makable while the press is operating.

Features of this new R-4 Press include extra-heavy construction; separate ejection and compression levers; screw adjustment for compression; independent ejection cam; twin disc clutch and combined brake that instantly starts and stops the machine, even under full compression load; variable-speed drive to obtain maximum production with materials and parts of varying characteristics and size; adjustable gibs to maintain close accuracy in punch and die alignment; and others.

Control for Flow Rate of Fluids

For automatically controlling the flow rate of fluids being measured with rotameters, *Fischer & Porter Co.*, Hatboro, Pa., has now developed the "Rotamatic" controller. It is connected to the rotameter through a self-operated induction bridge system, and operates a pneumatic system that positions the air motor of a diaphragm valve.

The Rotamatic is equipped with automatic reset and full throttling range for adjustment to the most complicated flow control problem. Remote reading indicators are supplied as desired. Now one can combine "automatic flow control" with wide flow range, visibility or metering elements, low pressure loss and linear calibration scales.

The rotameter consists essentially of a tapered pyrex glass tube within which a metering float moves up and down, and with it highly accurate flow rate readings may be obtained, even with viscous or highly corrosive fluids.

TRUE OR FALSE?

All Black Oxidizing Processes for Steel are the Same

FALSE!

All Steel Oxidizing Processes are Not the Same

The Oxidizing Salts are Different

The Procedure Is Different

The Results are Different

If you are not getting the results that you should with the black oxidizing process that you are using, it will pay you to call on Du-Lite. Our engineers are specialists in solving the problems of black finishing steel.

Or if you are planning to use a black oxide finish for the first time, Du-Lite will study your individual problem, and make recommendations.

Why not take advantage of the service of specialists? Wire or write Du-Lite today for prompt attention.

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Specialists in Black Oxide Finishes for Steel Parts

MIDDLETOWN, CONNECTICUT

Portable Radial Cutting Machine

A portable radial cutting machine, carried by two men, has been introduced by *DeWalt Products Corp.*, 1000 Fountain Ave., Lancaster, Pa. Though primarily for the woodworking shop, it will cut light metals, ferrous and non-ferrous, when equipped with metal saw or abrasive wheel.

It will cross-cut material 14 in. wide by 1 in., 12 by 3 in. with 12 in. saw and rip from 0 to 26 in. wide. It will miter, rip, bevel cut off, double miter and bevel rip.

The unit features three simple DeWalt radial adjustments. The sturdy cantilever arm moves vertically, swings horizontally. The yoke rolls along the arm, rotates horizontally. The motor in it tilts at any angle.

Regardless of the operation being made, the machine is perfectly balanced, since the weight of the motor is always in line with the center line of yoke, arm and column.

We Want Back Copies of METALS AND ALLOYS!

METALS AND ALLOYS is very desirous to receive back copies of this magazine for seven consecutive months, and is appealing to readers to furnish them. A price of 50 cents each, plus postage, will be paid for each of the following issues: August, September, October, November and December, 1929; also January and February, 1930. Please mail to H. A. Knight, News Editor, METALS AND ALLOYS, 330 W. 42nd St., New York 18, N. Y. Enclose a slip of paper inside the front cover, containing your name and address, so that we can pay you. Thanks!

Two-In-One Dip Tanks

Two hot liquid dip tanks in one portable unit enable the operator to clean and rinse metal parts and products without carrying them to a second tank for hot or cold rinsing. Made by the *Aeroil Burner Co., Inc.*, West New York, N. J., it plugs in on 110 or 220 volts a.c. or d.c. for instant heating and is called the Twin Dipmaster.

It has two insulated compartments separated by an insulated partition, and has two removable immersion tube heating units. Separate automatic heat control is provided for each compartment through thermostats, which regulate any required temperature from 110 to 550° F.

Two built-in thermometers registering from 100 to 600° F., and four dipping baskets are included. There are scum gutters, draw-off cocks, insulated cover, pipe connections for fresh water and drainage, and two work grilles for resting bulky parts.

(Continued on page 234)

THERMONIC

THE MOST EFFICIENT AND ECONOMICAL SYSTEM FOR INDUCTION HEATING

HITLER & CO.

SHIVER

WHEN

THIS "ORGAN"

PLAYS

The "organ" reproduced to the right, and so vividly dramatized by Noblitt-Sparks, is a Thermonic production set-up. It "plays off" an "octave" of highly specialized brazes every 65 seconds . . . 440 per hr!

The tall, pipe-like parts shown at the right are burster wells (aerial bomb exploders) in the stage of going through an important brazing step, while the large central illustration visualizes the actual operation involved. The requirement here called for brazing a small screw machine part onto the end of a steel tube . . . the condition being that the inside threading of the pieces be kept free from the flow of the brazing alloy!

That this brazing operation was successfully and speedily accomplished by Thermonic is in no uncertain terms indicated by the Noblitt-Sparks copy headline! It packs a knock-out punch!

The versatility of Thermonic Induction Heating equipment is doing much to speed up vital war requirements. . . . It is boosting production by reducing, from minutes to seconds, operations calling for Brazing, Hardening, Forging, Melting and Annealing. . . . It cuts power and maintenance costs to fractions. . . . And unskilled labor quickly becomes expert in handling its many functions.

For complete information about our equipment's proven advantages, we invite your inquiries. The counsel of Thermonic's engineering staff is at your service.

INDUCTION HEATING CORPORATION · 389 LAFAYETTE STREET, NEW YORK 3, N. Y.

Largest Producers of Electronic Heat Treating Equipment for Brazing Melting Annealing Forging Hardening

Reel Feed for Profilers

Addition of an automatic reel-type feed mechanism for handling tubes and rods in and out of their patented self-centering type chucks on Pines profilers is announced by *Pines Engineering Co.*, Aurora, Ill.

The profilers burr, bore, center, face, thread, turn, drill, chamfer and ream one or both ends of tubes or rods simultaneously. Several operations may be performed at the same time, and either identical or varied operations may be done on opposite ends.

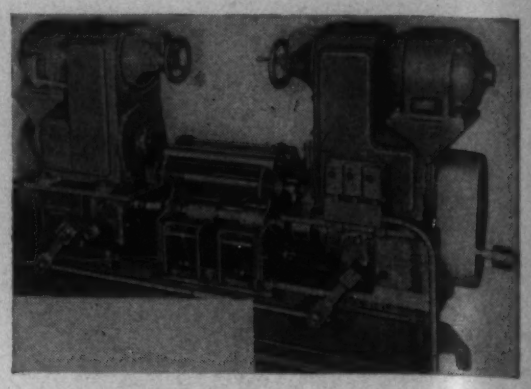

Illustration shows a Pines profiler equipped with two chucks for holding 3 in. in diam., 24 in. long tubes, which are end-faced and chamfered simultaneously. The left machine head and chuck are adjustable on the machine bed to accommodate tubes or rods up to 6 ft. long. The chucks are equipped with liners for processing tubes or rods from ½ in. to 3 in. in diam.

The reel feed has increased production from 600 to 1200 tubes per hr. It can be used with a chute and loaded by the operator at the cut-off machine, the profiler requiring only occasional attention by an unskilled worker.

● "Markal N" paint stick marker for use on all cold surfaces is announced by *Markal Co.*, 6 E. Lake St., Chicago. It is real paint and produces permanent fade-proof, weather-proof markings on metal, lumber and many other materials. It is particularly suitable for layout purposes on steel plates, whether bare or coated with zinc chromate or other protective coatings used in pickling. The sticks are in 6 colors and dry in 10 min.

Wire Wind-up Machine

A new wind-up machine for wire, cable, cord, etc. has been developed by the *Industrial Oven Engineering Co.*, 11621 Detroit Ave., Cleveland. Built originally for the firm's cable lacquering equipment, it is now available in two standard sizes.

It contains variable speed and hydraulic synchronizing equipment, providing constant speed and constant tension within a variable production range. Wire tension can be varied from a few ounces to hundreds of pounds.

It comprises a dismountable reel stand, multi-wrap large-diameter capstans, constant but variable tension mechanism, and adjustable level winder.

FACILITATING DELIVERIES OF SEAMLESS TUBING

tolerances . . .

If you will consider the range of tolerances to be found in the three finishes of steel tubing it will help you in placing your order.

FOR WIDE TOLERANCES

Where individual lengths are chucked into turret lathes and wide tolerances are acceptable, specify Hot Finished Tubing which receives no further sizing operation after it leaves the hot sizing mill.

FOR CLOSER TOLERANCES

For work such as that done on Automatic screw machines specify Cold Finished Tubing. It is sized by cold working the tubing after it leaves the hot sizing mill which results in the close tolerances required for successful collet operation.

FOR BEST O.D. TOLERANCES

Where best outside diameter tolerances are required specify Rough Turned Tubing. Its close O.D. tolerances are secured by machining the outside surface of Hot Finished Tubing. The inside diameter of this tubing receives no finish beyond that provided in the hot sizing mill. The use of Rough Finished Tubing will provide a minimum of down time on automatic machines.

Timken Seamless Tubing is supplied with the tolerances required for your needs in a wide range of sizes and grades of carbon, alloy and stainless steels. Timken Engineers will gladly help you select the proper tubing. Steel and Tube Division, The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN

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SEAMLESS STEEL TUBES

CUTTING FLUIDS DESERVE YOUR SERIOUS ATTENTION

Well informed authorities have made the statement that more intelligent application of cutting fluids and better tool grinding would make possible a 30% increase in metal-working production. In these days of man-power shortage, what a challenge that statement presents!

Be honest . . . in your plant are cutting fluid problems given the attention they deserve? Are your performance records accurate? Are you aware of what better cutting fluids can do for the job? Or is your attention centered on other fields until real trouble develops which might be traceable to improper use of cutting fluids? Hundreds of metal-working plants are getting the most out of their cutting fluids by working closely with the Stuart service engineer. They know that there is no universal cutting fluid, no magic compound—but when a Stuart product is put on the job they are sure they have every cutting fluid advantage that broad engineering experience and "know how" can give them.

To be sure you have all the advantages, work with the Stuart service engineer, representing a company which has specialized in metal-working lubrication since 1865.

We invite you to write for our new free booklet, "The 577th Oil," which contains twenty-two case histories, typical examples of how Stuart engineering is solving production problems. (like your own), as well as other valuable metal-working data. State your name, company and title.

A REQUEST OF STUART CUSTOMERS

Containers of all types are critically scarce. We urge you to cooperate with the W.P.B. program to conserve containers by observing these four rules for handling drums.

1. Do not drop.
2. Use a little oil to avoid stripping threads in removing plugs.
3. Replace plugs carefully when drum is empty.
4. Keep drums under cover when emptied.

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LIMITED
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CHICAGO 23, ILLINOIS
ESTABLISHED 1865
Warehouses in Principal Metal-Working Centers

STURACO · SOLVOL · KLEEN KUT

Improved Underwater Cutting Torch

An improved underwater cutting torch, Model 3900, is announced by *Victor Equipment Co.*, 844-54 Folsom St., San Francisco. The air mantle limits the annoying slagging of the tip.

Adjustments can be made under water without losing parts. Gas control valves can be more easily manipulated with heavy gloves and in murky water than before.

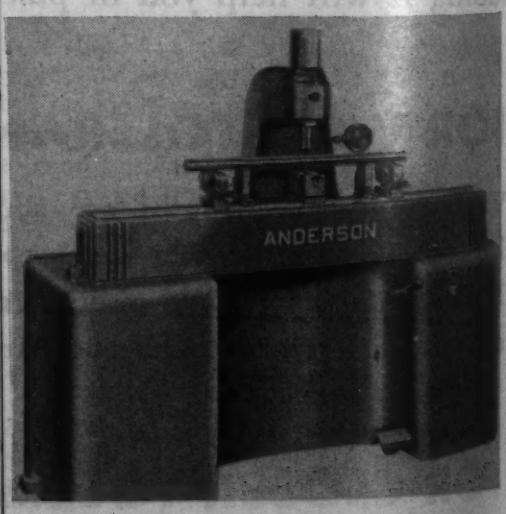
The torch will start the cut and proceed faster than previously, and is more easily maintained in service.

● A line of solid round Kennametal tools already ground and ready for use in precision boring machines is announced by *Kennametal, Inc.*, 158 Lloyd Ave., Latrobe, Pa. Heretofore solid round blanks only were supplied. The new tools are designated 27SR, having a side cutting edge angle of 30 deg., end cutting edge angle of 38 deg. for use in a 30 deg. boring bar; and the 29SR, with angles of 45 and 53 deg., for a 45 deg. bar.

Hydraulic Straightening Press

A hydraulic straightening press, with capacity of 10 tons but so sensitive that a shaft may be bent as little as 0.001 in., is announced by *Anderson Bros. Mfg. Co.*, 1907 Kishwaukee St., Rockford, Ill. The pressure gage, which indicates the ram loading, is mounted near the work at eye level.

Beneath the ram, at the point of maximum deflection of the work, is an adjustable dial indicator that shows the amount of shaft run-out in the pre-loaded, fully loaded and unloaded positions.



A rotary valve provides for flexible, sensitive control of the press. An infinite range of loading up to capacity is obtainable as the lever is moved from 0 to maximum displacement. Control of the hydraulic unit is by push button.

Safe operation is assured by the spring return mechanism of the control lever, release of which reduces the load immediately and causes the ram to return rapidly. Rapid ram return speed and ease of operation are other features.

Here Comes Tomorrow

The roar of a powerful motor breaks the crisp, winter stillness. Down the road moves a mechanical monster gulping tons of snow and spewing it aside. And the way is cleared for traffic.

The rotary plow that eats its way through snow drifts is not new—but, like all kinds of machinery, it will do a better *job tomorrow. Designers and engineers have acquired rich, new knowledge during wartime to help them create and produce the finer machines the new world will need. And Republic's fine Electric Furnace Steels will aid them in achieving the efficiency and economy so necessary in postwar markets.*

* * *

Republic Electric Furnace Steels enable manufacturers to do things not possible, practical or economical with other steels—even with other metals.

They bring you lighter weight, greater strength and toughness. They provide resistance to wear and corrosion. They increase the span of product life. They help effect lower fabricating costs.

They include special steels, alloy steels, "aircraft quality" steels and stainless steels—the same top-notch steels which are now demonstrating their abilities so decisively in American fighting machines.

They are "targeted steels". They are accurately aimed at exacting product and processing specifications *and held to that mark throughout production,* because of the close control possible only in electric furnace melting.

Manufacturers can economically apply mass production methods in fabricating these Electric Furnace Steels, because they are consistently uniform in quality. They make products look better, sell better, and give greater dollar value.

To meet wartime demands, Republic *—pioneer in electric furnace steels—* has jumped its capacity more than 900%. After the war these steels will be available to improve *your* products—to make better things to live with and to work with—in industry, in the home and on the farm. Republic Steel Corporation, General Offices—Cleveland 1, Ohio. Export Department, New York 17, N. Y.

REPUBLIC

ELECTRIC FURNACE STEELS

alloy...stainless..."aircraft quality"

—for vital working and structural parts in the automotive, aviation, farm implement, machine tool, petroleum, railroad, chemical, food processing, marine, textile, refrigeration, heavy machinery, electrical, transit and general manufacturing industries.

Lancaster MIXERS

THE SCIENTIFIC COUNTER-CURRENT RAPID BATCH MIXING SYSTEM

Counter-Current Mixing... Balanced Mulling Action...

You Get BOTH in the "Lancaster"

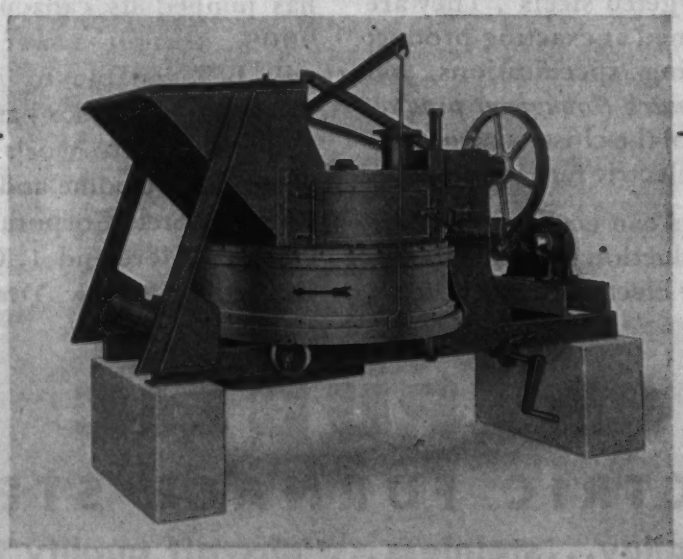
Two mixing actions contribute most to desirable batch development . . . 1. Counter-current mixing; 2. Balanced mulling action. The "Lancaster" is the only mixer which scientifically combines these modern mixing principles.

"Lancasters" charge fast . . . mix fast . . . discharge fast . . . conserve floor space . . . contribute to improved man-hour productivity. "Lancaster" Mixers are being successfully used for more than 30 diversified mixing processes, including precision formulas for products such as: Abrasives, Bituminous Compounds, Catalysts, Ceramics, Chemicals, Concrete and Cement Mortars, Foundry Sands, Glass (including Opticals), Mycalex Products, Powdered Metals, Refractories (including Refractory Mortars), Steatite, Vitreous Enamels, Welding Electrode Coatings and many others.

In the "Lancaster," counter-current mixing is conducted on a horizontal plane to avoid segregation. No "dead spots" are created. The entire batch receives *uniform* and *intensive* mixing-mulling action. Simplicity of construction minimizes maintenance . . . permits quick, easy cleaning.

Illustration shows how material is conveyed by clockwise rotation of mixing pan and deflected by stationary side wall plow into the path of counter-clockwise rotating plows and muller which are established off-center of pan diameter.

Let us submit recommendations to suit your individual mixing requirements. Write today—no obligation.

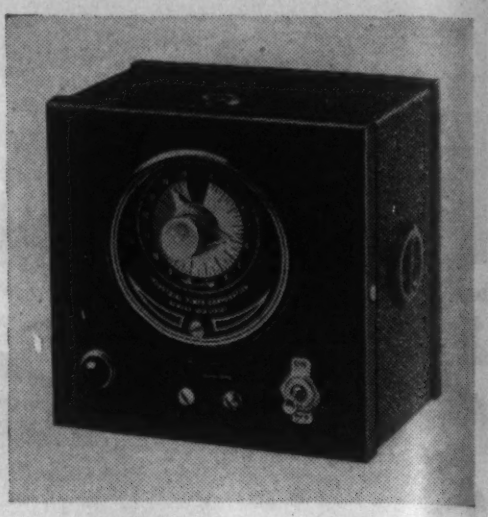


"Lancaster" Mixer, Symbol EMG. Closed pan type, fitted with full batch stationary hopper.

LANCASTER IRON WORKS, INC.
BRICK MACHINERY DIVISION
LANCASTER, PENNA., U. S. A.

Signalling Timer

A new signalling timer is designed to command visual and audible attention the instant a time interval is completed. Called Series S, it is made by the *Industrial Timer Corp.*, 117 Edison Place, Newark, N. J. It provides for automatic closing or opening of a circuit at the end of elapsed time, and operates additional buzzers, bells or lights at remote locations.



When the pointer on the timer is manually set to the required interval shown on the dial, a circuit is closed that operates a pilot light indicating that the time interval has started. The moving pointer revolves counter-clockwise toward zero. Time elapsed is constantly shown on the dial.

Upon interval completion, an alarm sounds and the light extinguishes. The buzzer sounds until the toggle switch on the timer is snapped to off position, or timing interval again started. There are also certain optional provisions.

● A nickel alloy wire with diameter of 0.0009 in. has been produced by *Driver-Harris Co.*, Harrison, N. J., its use being a military secret. It is so fine that a pound would stretch more than 80 miles. It is so invisible that workmen go by feel rather than sight in drawing it through diamond dies.

Pipe Flaring Tool

A new, simple, economical flaring tool that will make correct double flares on all popular sizes of thin wall steel tubing from 3/16 in. to ½ in. for S.A.E. flare and inverted flare joints, is announced by *Imperial Brass Mfg. Co.*, 1200 W. Harrison St., Chicago 7. It will make single or double flares on copper and aluminum tubing.

The tool folds back the end to make a flare with double-thick and strength walls, avoiding splitting. It can be handled on the job, and deals with the most widely used tubing sizes. The tool first bells the tubing, using an adapter; then completes the double flare, as does the conventional flaring tool.

The complete tool consists of a flaring bar, yoke and five adapters.

APEX

FOR THE RIGID SPECIFICATIONS

WHICH ARE SYMBOLIC OF VICTORY,

APEX IS 100% GEARED FOR WAR...

AND WILL BE 100% GEARED FOR PEACE

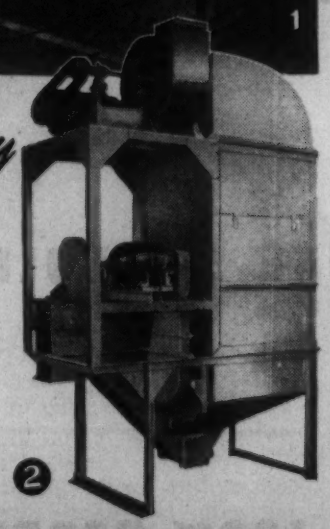
SMELTING

COMPANY

CHICAGO, ILLINOIS

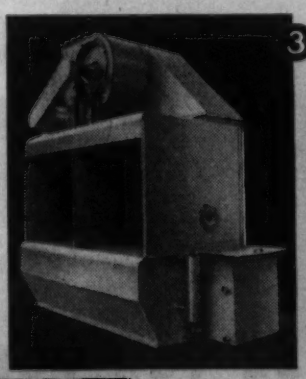
MAKES FOR GREATER *Plant Efficiency*

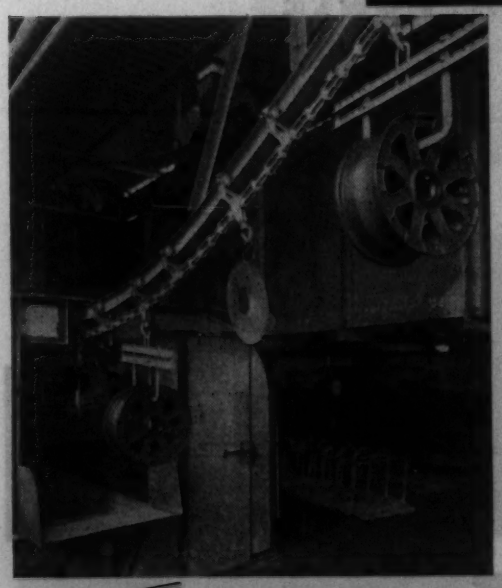
Whatever your requirements in dust collecting units, ventilating systems, ovens, paint spray booths, etc., Peters-Dalton, Inc. engineers—through long and varied experience—can solve the particular problems pertinent to your plant. Shown here are typical installations of Peters-Dalton, Inc. equipment designed and built to successfully meet dust control problems in all types of organizations. Feel free to call upon us—our wealth of experience, recommendations and fullest assistance are yours for the asking.



1. A Peters-Dalton, Inc. installation designed for large department devoted to double spindle grinding and polishing lathes. In foreground is a 28,000 C.F.M. Hydro-Whirl unit.
2. A rotor type 4,000 C.F.M. Hydro-Whirl designed for core sand handling.
3. Booth type Hydro-Whirl collector suited for flexible shaft grinding and burring operations. Center divider removable, making full-width single booth if desired.
4. Closeup of booth showing grinding of large magnesium parts—one of a battery of Hydro-Whirl units.

Peters-Dalton, Inc. Hydro-Whirl Collectors are accepted standard for magnesium dust collecting.





OVENS *and*
Paint Spray Systems
by PETERS-DALTON, INC.

We are specialists in the laying out and installation of complete systems, large and small—from the cleaning stages through paint spraying and drying ovens. View shows part of the complete conveyorized finishing system for handling bomber wheels. Spray booth in foreground; the drying oven overhead, thus providing more useable floor space.

Consult us on your individual problem.

HYDRO WHIRL **PETERS-DALTON** *Incorporated*

608 EAST FOREST AVE. • DETROIT 1, MICH.
(Formerly Industrial Sheet Metal Works)

MFRS HYDRO-WHIRL DUST COLLECTORS AND SPRAY BOOTHS—INDUSTRIAL OVENS, MECHANICAL WASHERS AND VENTILATING SYSTEMS

Applications for Synthetic Rubber

A major portion of its line of natural industrial rubber goods has been converted to synthetic rubber, and in many instances the latter is superior, particularly where resistance to oil, acids, detergents and similar material is desirable, states the *Goodyear Tire & Rubber Co.*, Akron. Synthetic rubber for mechanical rubber goods also withstands wider temperature ranges.

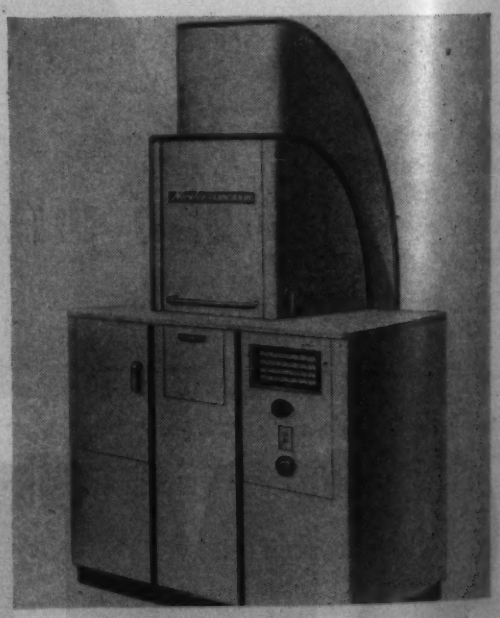
The synthetic material has been adapted to transmission, conveyor and elevator belts, hose V-belts, rolls of all kinds, molded products and similar materials.

● Iron can be used instead of copper and nickel for printing plates, as a result of research conducted by *Battelle Memorial Institute*. Ferrous sulphate, ferrous chloride and ammonium chloride form a solution which deposits electrolytic iron for normal electrotyping. Iron anodes are used, the electrotype mold itself serving as cathode. The iron can be plated on treated lead molds or on wax molds previously oxidized with copper or silvered with a silver spray apparatus.

Machine for X-Ray Inspection

For X-ray inspection of parts, assemblies and finished metal products, hard rubber, plastic, Bakelite, ceramics, dielectric materials, etc., Searchray, Model 150, has been brought out by *Industrial Electronics Div., North American Philips Co., Inc.*, 100 E. 42nd St., New York, this being the second in a series.

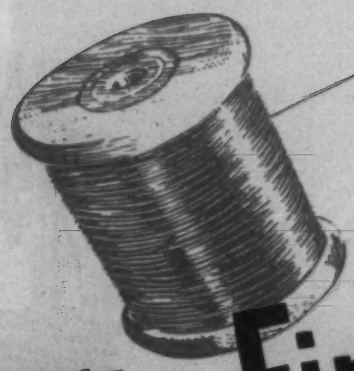
It allows for taking of highest quality sharp radiographs quickly by plant personnel under controlled conditions without a skilled X-ray technician, or lead-lined room.



It has fixed milliamperage over the entire range of 0 to 150 kv., and a device to interrupt the circuit while the compartment is open, insuring safety.

Adjustments can be made with relation to thickness of the specimen for greater clarity on the fluoroscopic screen. The field of vision can be limited to reduce glare. Mounted on sturdy rocker legs, it weighs 600 lbs.

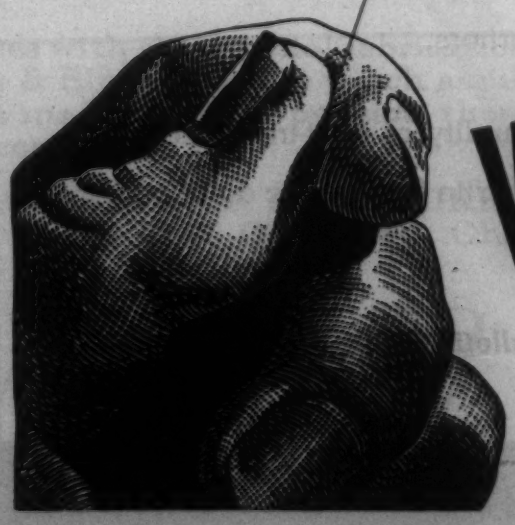
LITTLE THINGS THAT COUNT . . . .



Callite Fine Wires

FINE WIRES, in themselves, may seem minor parts in the engineering of products that do important war jobs — but they must be *right*. The success of the whole, hinges on the accuracy and dependability of all — working as a unit.

AT CALLITE we take a lot of trouble to make fine wires exactly as the user requires them.
Callite Fine Wires are drawn to the optimum properties of the metal or alloy desired, accurate in size, correct in temper, always uniform, easy to handle. Consult our engineers and metallurgists on the right wire for your purpose.
Callite Tungsten Corporation,
546 Thirty-ninth Street, Union City, N. J.
Branch Offices: Chicago, Cleveland.

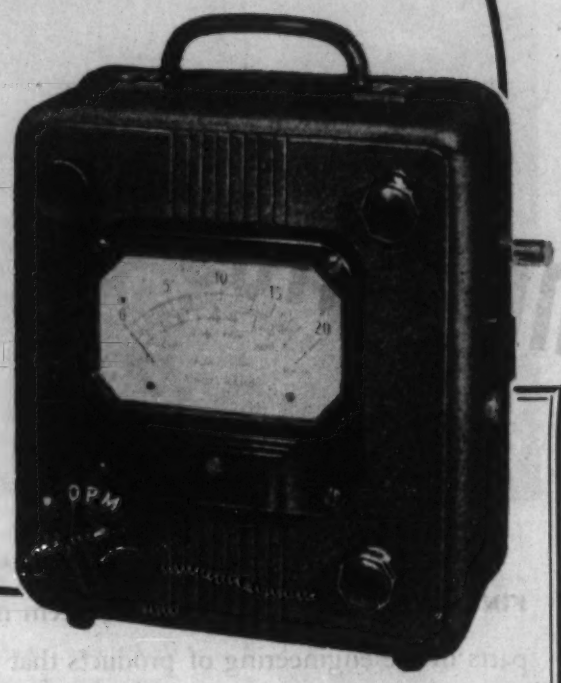


CALLITE WIRES

Beryllium Copper Aluminum
Phosphor Bronze Stainless Steel
Silver Commercial Bronze Everdur
Brass (all grades) Special Alloys.
Prompt delivery in sizes down to .002"
in any of the above metals.

How to Control CO_2 PERCENTAGE...

the
VITAL FACTOR
in
ATMOSPHERE HARDENING



THE ENGELHARD FLUALYZER

provides the answer to the long felt need for an accurate, easy-to-use method for the determination of CO_2 percentage in oxidizing and reducing gases used in atmosphere-type treating furnaces.

The Flualyzer is a portable, self-contained, extremely sensitive instrument which measures CO_2 content by the thermal conductivity principle of gas analysis . . . By its use, totally unskilled operators can keep a constant check on the efficiency of the atmosphere-producing burners.

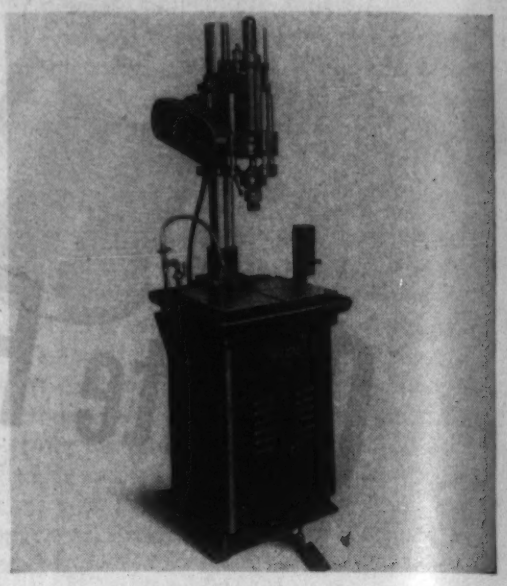
For increased uniformity and quality of heat-treated and carburized parts, it will pay you to write for specific details on the Engelhard Flualyzer *today!*

Ask for Bulletin 700

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY

Tapping Machine

A new series of light-duty lead screw type tapping machines, whose main feature is increased accuracy, is announced by *Detroit Tap & Tool Co.*, 8432 Butter Ave., Detroit 11. Designed for precision tapping in production, the new LTM machines have a rated capacity up to ⅞ in. in diam. and 14 pitch in mild steel.



Sturdy guide rods control the tapping spindle throughout the entire length of its stroke. The moveable head, in turn, guides the driving end of that spindle at a point between the tap and lead screw itself, eliminating the need for the lead screw to drive the tap.

Lead screw and bronze lead nut are interchangeable. The screw is of high-speed steel, hardened and ground all over, including threads. The nut can be adjusted easily to take up wear and remove backlash.

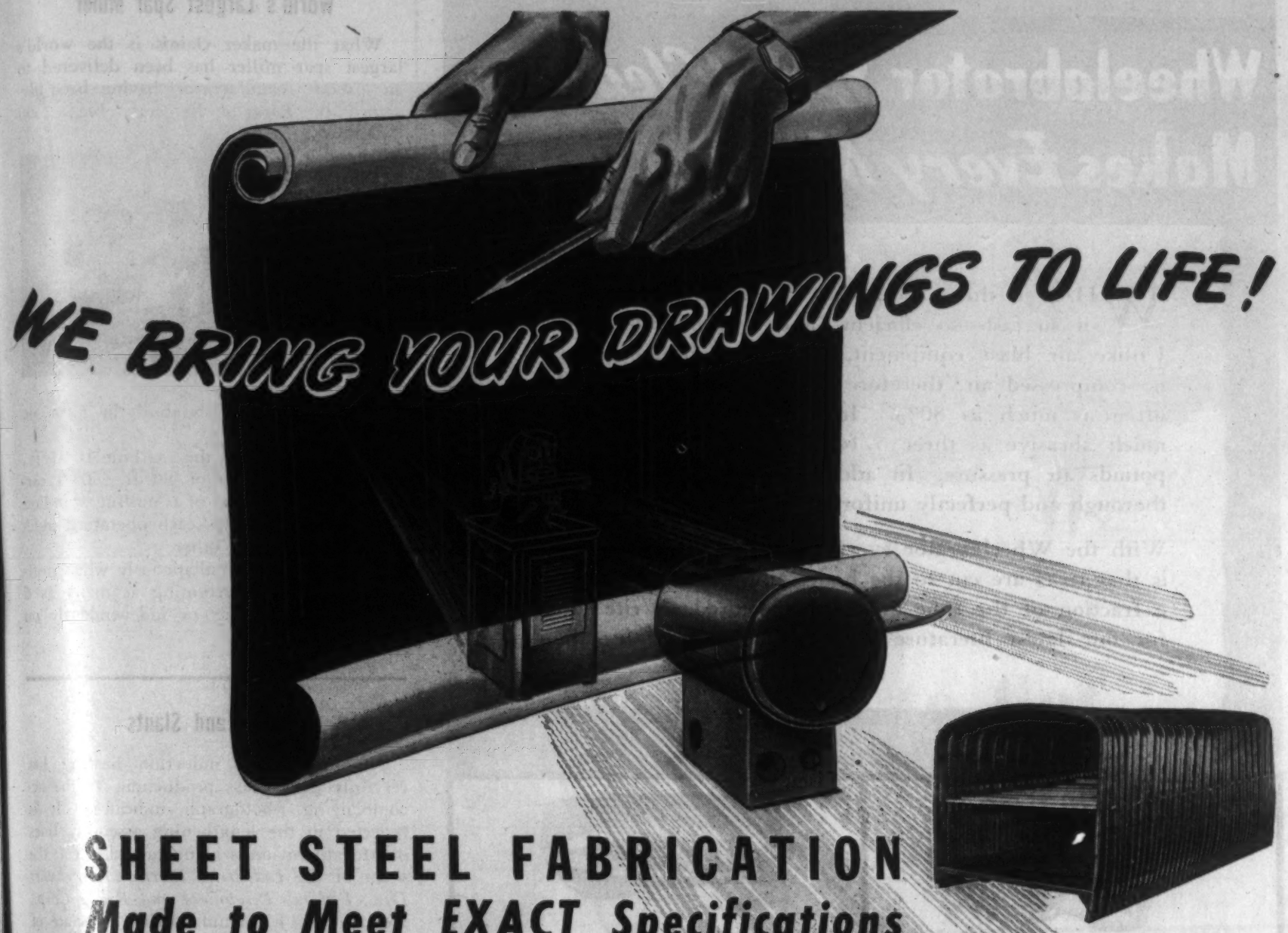
● To aid mills producing fine wire, *Carboloy Co., Inc.*, Detroit, has announced round hole cored dies in stock sizes down to 0.004 to 0.007 in. Previously, the smallest cored die available was a 0.015 in. hole size for finishing to 0.020 in. For smaller sizes one bought more costly rough drilled dies or blank dies for piercing by the mill.

Device for Duplicating Contours

The exact contour of irregular surfaces can be ascertained in a jiffy by the "Dupligraph," placed on the market by the *Inter-Lakes Engineering Co.*, 502 Transportation Bldg., Detroit 26. It transfers on transparent paper, or metal, the exact contour of the irregular object—say, a propeller blade.

It is particularly advantageous for securing concave readings in forming dies, which frequently cannot be checked with ordinary templates. It secures a true reading of a stamping, showing the amount of spring-back and warp. It gives cross-section lines relative to each other, usually done on vellum and checked against the draft or layout.

The result is a full contour line as against only a spot dimensional check by the common method.



SHEET STEEL FABRICATION

Made to Meet EXACT Specifications

For over a third of a century, fabrication of sheet metals has been an important part of the Kirk & Blum business. Throughout all these years, we have been guided by one fixed ideal: To interpret the customer's blue prints accurately, and produce finished work that exactly meets specifications.

We specialize in parts and assemblies of sheet steel (3/8" plate or lighter), stainless (all types), monel and other alloy sheet or plate. Modern expanded facilities, plus highly skilled workmen trained in the use of specially built equipment, enable us to produce accurately-made sheet metal parts faster and more economically. We are completely equipped for cutting, shearing, forming bending, rolling, welding, and assembling completed products and assemblies.

It just doesn't pay to take chances with sheet metal fabrication. Play safe...avail yourself of Kirk & Blum facilities which assure fabricated sheet metal products made the way you want them, when you want them—at low cost.

Send your blue prints, for prompt quotation to THE KIRK & BLUM MFG. CO., 2852 Spring Grove Ave., Cincinnati, Ohio.

KIRK AND BLUM

AN ORGANIZATION OF ENGINEERS AND MECHANICS

WRITE FOR BOOKLET, "DATA ON KIRK & BLUM PRODUCTION FACILITIES"

Wheelabrator *Speed Cleaning* Makes *Every Minute Count!*

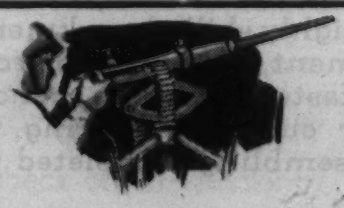
WHAT is there about the Wheelabrator that makes it so fast—so efficient—and so profitable to use? Unlike air blast equipment, the Wheelabrator requires no compressed air, therefore power is greatly reduced—often as much as 80%. It will throw three times as much abrasive as three 5/16" nozzles operating at 100 pounds air pressure. In addition, the blast coverage is thorough and perfectly uniform.

With the Wheelabrator every minute counts. The result is that costs are cut to the bone, and work is cleaned in a fraction of the time ordinarily required. Write today for our latest literature and ask for a demonstration.

A typical 27 x 36" Wheelabrator Tumblast load of forged micrometer frames at the Rhode Island Tool Co., Providence, R. I., requires only five minutes to remove scale from the 800 pound load.

Park Drop Forge Co., Cleveland, Ohio, has been cleaning 13 to 15 diesel engine crankshafts measuring 54" long and 3" diameter, weighing 200 lbs. each, in 10 minutes with their 48 x 72" Wheelabrator Tumblast.

A 20 x 27" Wheelabrator Tumblast is used by an eastern tool manufacturing company for cleaning a variety of carbon and high speed drills, taps, cutters and reamers. Typical loads consist of from 1,000 to 2,500 pieces and require an average of 15 minutes cleaning compared with 4 hours with previous equipment.



35 machine gun bases weighing approximately 22 pounds each, are cleaned in only eighteen minutes in a 36" x 42" Wheelabrator Tumblast at a railroad specialty manufacturing company.

ARMY NAVY

AMERICAN FOUNDRY EQUIPMENT COMPANY

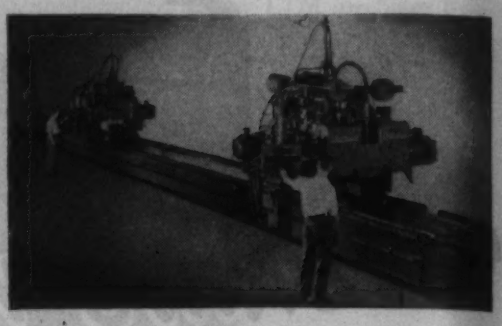
THE AMERICAN MOLDER

TRADEMARK REG. U. S. PAT. OFF.

538 S. BYRKIT ST., MISHAWAKA, IND.

World's Largest Spar Miller

What the maker claims is the world's largest spar miller has been delivered to an aircraft manufacturer, having been designed by *Paragon Research, Inc.*, 1600



Seneca St., Buffalo, and built by *Farnham Mfg. Co.*

Overall length of the machine is 91 ft., with a table length of 80 ft. Two carriages, having a total of 6 milling spindles, travel the bed length, each operating independently from the other.

They are used simultaneously when milling long spars, performing as many as 6 operations at a time, or independently on short spars.

Plants and Slants

High frequency induction heating has certainly gone mass production, as the accompanying photograph indicates. It is reflected in the lengthening assembly lines of Megatherm units being turned out at the plant of the *Industrial Electronics Product Div., Federal Telephone and Radio Corp.*, Newark, N. J., manufacturing associate of the *International Telephone and Telegraph Corp.*

Because megacycle electronic heating is an in-the-line process, it is expected to revolutionize production in many fields of manufacture and processing, including the metal industries where specific application of induction heating is required for controlled surface and spot heat treatment and in the dielectric field serving the plastics, food, textile, woodworking and other industries.

States an official of International Telephone: "This new tool is one of the most important contributions of the war era, and will have far-reaching effect in transforming manufacturing methods, changing equipment design, reducing costs, and speeding output."

Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, has opened up an organic research laboratory, with Dr. Nathaniel Baum as head. He had been consulting chemist in organic synthesis and resins at Chicago for the past six years. He received his doctor's degree in chemistry at Columbia University in 1930.

Led by the *Gary Sheet & Tin Mill*, the *Carnegie-Illinois Steel Corporation's* Chicago district plants won first, second and third places in the Greater Chicago Safety Council semi-annual interplant accident prevention contest in the division consisting of plants working more than 5,000,000 man-hours during the first six months of

It's Time to Get Light on Your Feet!

What with cancellations, cut backs and design changes, these are no days to increase surplus inventory. It's time to streamline your stocks to the utmost—to get "light on your feet" for post war operations.

To keep down your steel inventory, for instance — why not buy more from warehouse? Frasse stocks of cold finished bars, tubing, stainless steels, alloy and aircraft steels and tubing are now in good shape. By buying only what you need for immediate production, you avoid leftovers and dead stock when contracts change.

Your post war plans can be seriously hampered by heavy, awkward surpluses. Why pile up more when you have Frasse inventories handy to draw on? Call Frasse for your steel requirements first.

Frasse

MECHANICAL AND AIRCRAFT STEELS

SEAMLESS MECHANICAL AND AIRCRAFT TUBING

COLD FINISHED BARS • ALLOY STEELS • AIRCRAFT STEELS • DRILL ROD

STAINLESS STEELS AND TUBING • COLD ROLLED STRIP AND SHEETS • WELDED STEEL TUBING

17 Grand St., New York 13, N.Y. (Walker 5-2200) *Peter A. Frasse & Co., Inc.* 3911 Wissahickon Ave., Phila. 29, Pa. (Radcliff 7100—Park 5541)

50 Exchange Street, Buffalo 3, New York (Washington 2000) • Jersey City, N. J. • Hartford, Conn. • Rochester, N. Y. • Syracuse, N. Y.

It's What The User Says About Heat Treating Containers That Counts!

A producer of heat treating containers might, like any other manufacturer, wax overenthusiastic about his product, advancing claims based on what he has designed it to do. But what really counts is the performance of those containers in actual service, preferably as reported on by users. Accordingly, we will let users of Amsco Alloy heat treating pots write the balance of this message.

"The cyanide pot you furnished, your blueprint number SD-2385, has now been in service nine months. If you will recall, we felt that to equal the operating cost of a steel pot (not alloy) the cast alloy pot would have to stand up at least four months. Since the Amsco Alloy pot has gone twice that period, its life has been quite satisfactory. The pot is still in active service and at the time of the last examination there was no evidence of prospective failure."

* * *

"Your Amsco Alloy pot has been in service 2,600 hours and seems to be in good shape, even though certain others of another make and apparently of the same analysis lasted 1,000 hours or less."

* * *

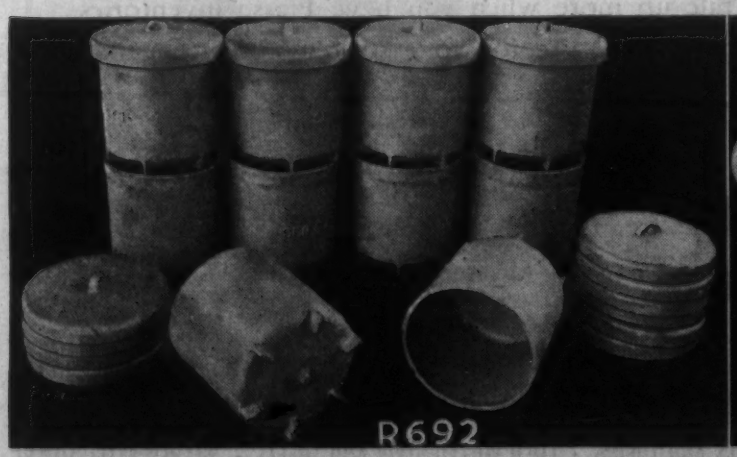
"Our Amsco Alloy pots handling neutral salts have given us the best service of any that we have ever used."

Nothing much to be added to the above, except that the names of the users may be had on request, and that heat and corrosion-resisting Amsco Alloy containers are available in a wide range of types and sizes for every heating and heat treating application.

Ask for Bulletin 1041-A.

R-692. One piece carburizing containers and covers.

R-433. A 20" x 20" cyanide pot, X-ray inspected and pressure tested.



Amsco

AMERICAN MANGANESE STEEL DIVISION

Chicago Heights, Illinois

AMERICAN Brake Shoe COMPANY

FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO.
OFFICES IN PRINCIPAL CITIES

the year. Gary Steel Works took second place and the South Chicago Plant, third.

A merger of two long-established firms in the metal products field will hereafter be known as the *Wade Mfg. Co., Div.* of *Woodruff & Edwards, Inc.*, with main offices and plant at Elgin, Ill., chief products being plumbing drains, marine fittings, etc. Woodruff produces fine quality castings, and is one of the largest jobbing foundries in the world. Wade has operated in that field over 75 years.

In a feature article on magnesium fires in METALS AND ALLOYS last May it was stated erroneously that the new "Commander" pump tank fire extinguisher of the *American-La France Foamite Corp.*, Elmira, N. Y. is "for incendiary bombs only." The word, "only" was unfortunate. Actually it is suitable for all "Class A" fires.

Westinghouse Electric & Mfg. Co. has formed a separate marine industry department in charge of Charles H. Weaver, who will direct all commercial activities.

Chicago district blast furnace operations of *Carnegie-Illinois Steel Corp.* established 31 new records in its tremendous war output in October. At the middle of November the twenty-third stack returned to production after a few weeks idleness for repairs, making for 100 per cent production. Meanwhile, in October Carnegie, for all its plants, made a new all-time world's record production of steel ingots, totaling over 2,000,000 tons, exceeding by more than 71,000 tons the previous record of last August.

The *Columbia Steel Casting Co.*, Portland, Ore., received the U. S. Maritime "M" pennant just at the time it was changing over from pouring the 15-ton Liberty ship stern frame to casting frames for the faster Victory ships. Prior to the war Columbia never poured castings bigger than 3½ tons. They made chiefly gold dredges, mining machinery and logging machinery. Now tanker frames weigh as much as 23 tons.

The Welker Machinery Co., Inc., Detroit, has been made special distributor for Tocco process induction equipment, making eight distributors who handle the Tocco line.

Cooper-Bessemer Corp. has opened a new factory branch office at 401 Rust Bldg., San Francisco, being the third now serving the West Coast area. The new office is in charge of John G. McKissick.

More than 40% of production operations formerly done by hand by skilled workers are now automatic or semi-automatic at *Eclipse-Pioneer Div., Bendix Aviation Corp.* More than 30% of the total employees are women. To break bottlenecks, 476 machines were built to simplify manufacturing, and 30,000 special tools or modifications of present tools were inaugurated. The company provided 20,000 tools and 40 "model" machines to sub-contracting firms.

Give him the answers before it's too late!

● When fire breaks out at your plant, will the confusion of your men give the blaze time to get out of control? Not if they've been shown exactly what to do. Men *who know how* act swiftly and confidently to nip small fires.

Make sure your key men have the training they need. Stage a demonstration now. Let them see your equipment go into action against real fires. Explain the different types of fire and the right way to fight each of them.

To help you plan an interesting, instructive show, Walter Kidde & Company has issued a booklet, "HOW TO TEACH FIRE FIGHTING." Write for your free copy today.

Kidde

WALTER KIDDE & COMPANY, INC., 131 MAIN STREET, BELLEVILLE, N. J.

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You'll find these Wiley books practical, authoritative and up to date. Whether you want a "refresher" or want to increase your knowledge—look over the Wiley books listed below. Select the books you need and mail the coupon now. Keep abreast of new developments in metallurgy. Act today!

FERROUS PRODUCTION METALLURGY
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By R. L. Dowdell, H. S. Jerabek, A. C. Forsyth and C. H. Green
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Briefs on Associations, Promotions and Education

A post-war planning competition for employees has been inaugurated by the Lincoln Electric Co., Cleveland, the purpose being to gather all the ideas of each employee to assist management in planning for the future. Possible post-war products and methods of manufacturing them are the chief topics. Prizes are $500, $300 and $100.

A 16-mm. color film with sound, showing the fabrication of ship stern frames by the Thermit welding process has been produced by Metal & Thermit Corp., 120 Broadway, New York. It is a 25-min. film, and is available for technical groups interested in ship building and welding.

At a meeting of over 200 representatives of Meehanite foundries of the U. S. and Canada the following officers of the Meehanite Research Institute were elected: President, Oliver Smalley, Meehanite Metal Corp., New Rochelle, N. Y.; vice president, H. B. Hanley, American Laundry Machinery, Rochester, N. Y.; secretary-treasurer, C. S. Nichols, Meehanite Metal Corp., Chattanooga, Tenn.

Speaking at the Management Luncheon, November 30, at the A.S.M.E. annual meeting, John R. Bangs said that the most important of all management's post-war job is employment. "Plans must be made now by the managements of individual companies throughout the land to achieve a level of production and consumption after the war estimated at from 35% to 40% above that of 1940. Only by doing so can it provide enough jobs to give employment to a group of people of from seven to eight millions higher than any previous normal period." Utilization of all technological improvements and developments, expansion of sales and production of each company, and reduction of costs of production and distribution were the methods suggested by Mr. Bangs, who is general manager, personnel and industrial relations, for Budd Mfg. Co., Philadelphia.

Good and bad housekeeping in industry are portrayed in a 12 min. motion picture, "The Magic Carpet," whose purpose is to promote plant safety. It is obtainable from the Waverly Petroleum Products Co., Philadelphia.

Chester Alan Fulton, president, Southern Phosphate Corp., Baltimore, has been elected president of the American Institute of Mining & Metallurgical Engineers for 1944. Two new vice presidents are John Livermore Christie, metallurgist and manager, Handy & Harman, Bridgeport, Conn. and J. Robert Van Pelt, Jr., geologist and technical director, Museum of Science and Industry, Chicago.

First prize of $200 in the metallizing contest conducted by Metallizing Engineer-

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ing Co., Inc., Long Island City, N. Y. in the first of its new series on conservation was awarded to R. C. Overstreet, Tinnerman Products, Cleveland, for his description of a faster, more durable way to protect speed nuts against corrosion. Second prize of $100 went to L. W. Sagle, Baltimore & Ohio railroad, showing how replacements are avoided and worn parts reclaimed quickly and cheaply.

An iron ore research laboratory at Duluth, Minn. will be established by the Oliver Iron Mining Co. with an end towards improving Lake Superior district iron ores.

A 3-year study on standard packaging methods for steel has been completed by the American Iron and Steel Institute. Processes and materials are fully described in an illustrated 180-page manual. It contains instruction approved by the Army Service Forces, Navy Department and Treasury procurement division for the wrapping, tying, boxing, marking and loading of a wide range of steel products. Packages must be made immune to tropical heat or Polar cold. Various purchasing missions were consulted.

For the most outstanding research work in any field of engineering Benjamin J. Lazan, chief engineer, Sonntag Scientific Corp., Greenwich, Conn. was awarded the Alfred Noble prize for 1943 at the annual dinner of the A.S.M.E. on December 1. His winning paper was: "Some Mechanical Properties of Plastics and Metals under Sustained Vibrations."

A new arc welding contest is announced by Hobart Bros. Co., Troy, Ohio, whereby $200 will be paid each month to those successfully writing personal accounts of how arc welding has been used to advantage by them.

In recognition of his outstanding work in applied chemistry, Gaston F. Du Bois, vice president, Monsanto Chemical Co., has been elected to receive the Perkin medal. In the metals field he produced notable achievements in the electrochemical separation of bismuth and the development of the vanadium pentoxide catalyst in this country.

A warning that "the major shock to our economy will come immediately after the end of the fighting in Europe, and not at some later date after Japan has been crushed," was sounded by John F. Fennelly at A.S.M.E.'s post-war sessions, November 30. Army experts now estimate that we may cut munitions production 80% after Hitler's defeat and still have enough accumulated material to crush Japan, he said.

Men of military service age in professional, technical and scientific work in war production or a war-supporting activity may be assured that review of their cases involving occupational deferment may continue to be made by the National Roster of Scientific and Specialized Personnel in Washington, stated the War Manpower Commission on November 15. All Selective Service local boards have received necessary details.

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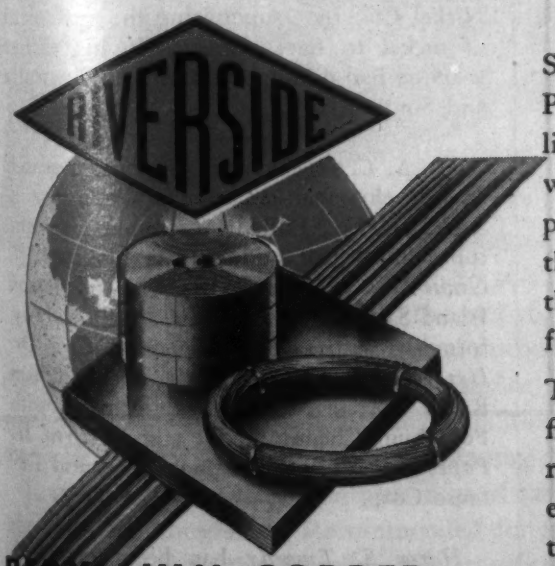

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News of Engineers

Thomas T. Watson has been appointed director of research of Lukens Steel Co., Coatesville, Pa. and its divisions, By-Products Steel Corp. and Lukenweld, Inc. He had been research metallurgist in charge of that department of Lukens Steel Co. *D. Bruce Johnston* has been made assistant to the director of research, and *Samuel D. Lemmon* is made research metallurgist. Mr. Watson was graduated from the Royal Technical College in Glasgow in 1923 and received his early training in metallurgical research in Scotland and England.

Dr. Leo Lehr Carrick has been appointed director of red lead research and consulting chemical engineer of the Lead Industries Assn., New York. He has had a distinguished career in paint technology.

E. L. Huff has been made chief engineer of all plants of Allegheny Ludlum Steel Corp., having formerly been chemical engineer at the Brackenridge plant of the same corporation.

Frank W. Curtis, former president of the American Society of Tool Engineers, has resigned as chief engineer, Van Norman Co., to become development engineer with Induction Heating Corp., New York. He will help solve induction heat treating problems in New England.

Harry Weaver has been appointed foundry engineer for the Brillion Iron Works, Inc., Brillion, Wis. Formerly foundry engineer for the Caterpillar Tractor Co., for the past year and a half, he has been setting up an aluminum cylinder head foundry that is well known for its efficiency.

Reuel E. Warriner has left the Tank Automotive Center of the Army Ordnance Dept. and resumed duties with International Nickel Co., Inc., supervising the movement of nickel to steel makers. In his earlier years he had mining experience in Australia and South Africa.

Dr. S. C. Ogburn, Jr., manager research and development department, Pennsylvania Salt Mfg. Co., Philadelphia, announces the following recent additions to his staff: *J. Grant-Mackay,* formerly with Jefferson Island Salt Mining Co.; *Francis E. Murphy,* formerly with General Chemical Co.; *Dr. Herbert E. Ricks,* formerly with Gutham Radio Co.; *W. C. Wolfe,* formerly with Petroleum Chemicals, Inc.; and *Alfred H. Pope,* formerly with General Chemical Defense Corp.

Harry S. Tweedy has been appointed manager, field service div., Detrex Corp., Detroit 27, metal cleaning engineers. He has been chief inspector of production in all Detrex plants since December 1940 and prior to that served for four years as a design engineer. He has done considerable teaching.

Robert T. Dunlap has been made assistant to the president, Wickwire Spencer Steel Co., being well known in the steel industry as an authority on plant installations, production and operation. Prior to joining Wickwire he was general works

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manager of the Vulcan Iron Works, Wilkes-Barre, Pa. He has also served with Jones & Laughlin Steel Corp. and with Elliott Co., Jeanette, Pa.

William G. Theisinger, director of welding research, Lukens Steel Co., has been appointed assistant to the vice president, where he will work with manufacture, sale and application of special products, such as clad steels. Other connections have been Western Pipe and Steel Co., Harrisburg Steel Corp. and N. Y. Board of Transportation.

Thomas H. Glaser has been made installation engineer and tooling consultant with Gray-Mills Co., Chicago, maker of portable coolant systems and industrial fluid coolers.

Otto E. Zahn has been appointed assistant works manager of American Foundry Equipment Co., Mishawaka, Ind., with general supervision over all manufacturing operations. Previously with the same company he has been industrial engineer, development engineer and acting general superintendent.

Edmund Dana Campbell, general mechanical engineer for American Car & Foundry Co., has been elected a vice president. He is author of several articles on railway artillery and railroad equipment. *John A. V. Scheckenbach* has also been made a vice president, having been with the company since 1909 as design engineer and then as construction and improvement engineer.

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SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. January 10-14, 1944.

ELECTRON MICROSCOPE SOCIETY OF AMERICA. New York, N. Y. January 14-15, 1944.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting. New York, N. Y. January 19-21, 1944.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, national technical meeting. New York, N. Y. January 24-28, 1944.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. January 25-27, 1944.

NATIONAL SCREW MACHINE PRODUCTS ASSOCIATION, annual meeting. New York, N. Y. January 27-28, 1944.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, 50th anniversary meeting. New York, N. Y. January 31-February 2, 1944.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. February 20-24, 1944.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting. Cincinnati, Ohio. February 28-March 3, 1944.

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trends

By Edwin F. Cone

"Deglamorizing" Plastics

There is a tendency in the plastics industry to too much "glamorization," and a movement is on foot to "deglamorize" plastics and the uses to which they may be put—such as their competition with metals and other materials. This will be part of the work of a post-war planning committee, formed at the last convention of the Society of the Plastics Industry. There have been "too many Sunday supplement features about plastics which have characterized plastics as the 'miracle whip' material with which anything can be done."

Plastics and Metals

The main competition for the plastics industry after the war will come from materials and metals outside the industry, said Charles C. Livingston of the Cruver Mfg. Co., at the last convention of the Society of the Plastics Industry. He cited aluminum and magnesium alloys, and other light materials such as glass as aggressive competition with new and varied products and applications.

New Records in Steel Shipments

Record shipments of 6 major classes of steel products in 1943 were apparently made, says the American Iron and Steel Institute. Based on data for 9 months total shipments of all classes of steel products were 49,899,000 net tons or more than 1,100,000 tons in excess of the total for the same period in 1942. The 6 classes of major products referred to include steel plates, hot-rolled and cold-finished bars, both carbon and alloy steel, and also seamless steel pipe and tubing.

Blast Furnaces Added in 2 Years

The total number of pig iron blast furnaces continues to grow. There were 9 furnaces completed at the end of 1942 and 12 more are expected (December) to go into production in the next few months. This will bring the total number in the country to 250 with a capacity of 70,000,000 net tons of coke pig iron and ferroalloys. In 1941 the capacity was 57,610,000 tons.

Larger Output of N.E. Steels

That the manufacture and use of the N.E. steels has reached large proportions is reported by the American Iron and Steel Institute. It is estimated that these steels in 1943 will have reached a total of 4,250,000 net tons or about one-third of the year's total alloy steel. This has been accomplished in about 2 yrs. Conversion of this amount of standard alloy steels to the N.E. steels is expected to save the nation 24,000 tons of nickel in 1943 at the cost of no increase in the use of chromium and with rises of only 3000 tons for molybdenum and 8000 tons for manganese.

Steel Capacity in Latin America

Capacity for making steel in Latin American countries is gradually increasing. A study by the American Iron and Steel Institute reveals a combined capacity for those countries of about 1,400,000 tons of steel ingots and castings when all plants are constructed. Brazil and Mexico, with 570,000 and 600,000 tons respectively, will account for about 85 per cent of the total Latin American steel industry. Plants in Peru (140,000), Argentina (65,000), Chile (20,000) and Colombia (5,000) will represent a little more than 15 per cent.

Steel for Brazil

Brazil plans to have a steel plant in operation in 1944 which will have a capacity of 350,000 tons of ingots per year. It is now being built by American and other engineers at Volta Redonda on the main line railroad between Rio de Janeiro and Sao Paulo. It will furnish finished steel for industries in these two cities.

Alloys from Scrap Steel

Recovery of alloying metals from steel scrap in the manufacture of the N.E. steels, whether electric or open-hearth, is of definite proportions. The American Iron and Steel Institute reports that "as much as 30 per cent of the chromium content, 25 per cent of the molybdenum, and 50 per cent of the nickel requirements are obtained from the charges of selected alloy steel scrap which go into the melts."

Electric Steel Furnaces

Some measure of the expansion of the American electric steel industry is afforded by authoritative data presented at the October meeting of the Electric Furnace Steel Committee of the A.I.M.E. Of the 344 steel foundries in the United States, 276 plants are using 508 furnaces. There were then 68 electric furnace plants making steel ingots and in these there were 201 electric furnaces. Thus in the entire steel industry there was then a total of 709 electric furnaces producing steel ingots and castings.

Post-War Alloy Steel

Peacetime demand for alloy steel will more closely approximate 7 per cent of the total steel production rather than the present figure of 16 per cent said Charles M. Parker, of the American Iron and Steel Institute, at a meeting of the American Marketing Association. In his opinion this material will not lose any part of its position due to inroads made upon it by other materials.